POWER PLANT ENGINEERING

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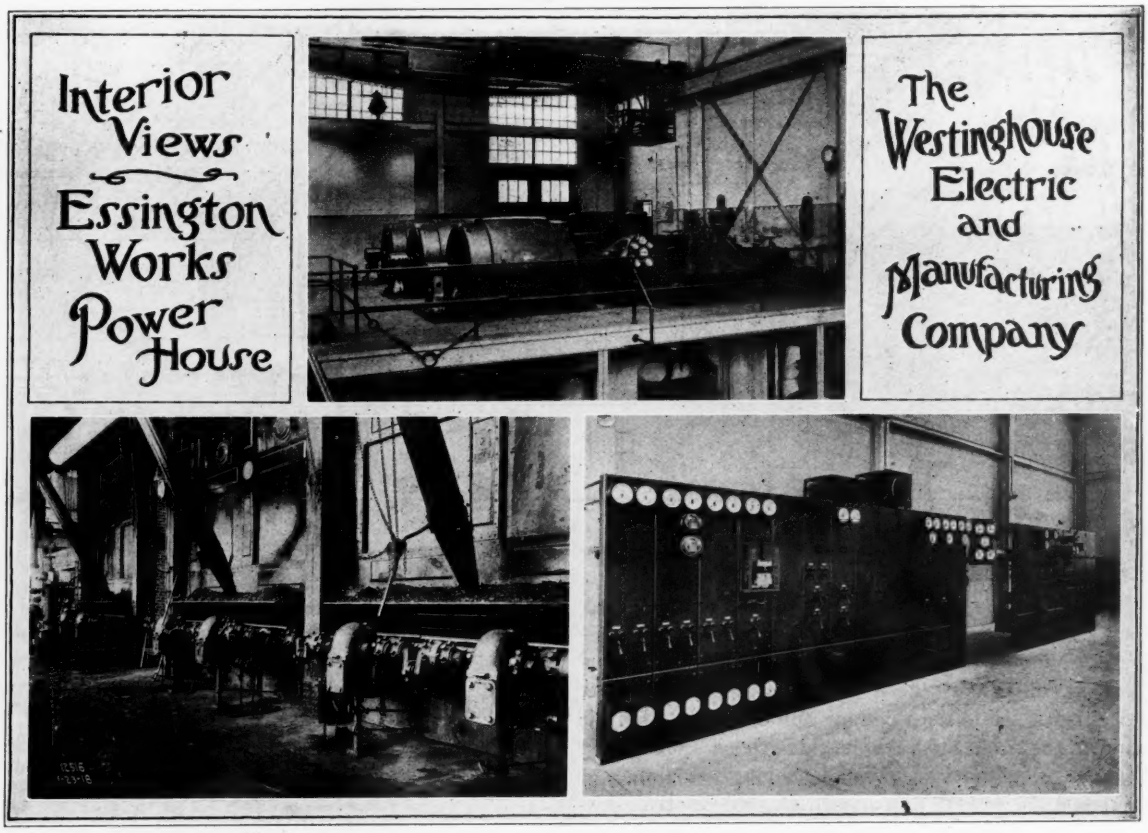
The New Westinghouse Plant

ESSINGTON WORKS EMPLOYS BOTH ISOLATED PLANT AND CENTRAL STATION SERVICE; LARGE VOLUMES OF HIGH-PRESSURE, SUPERHEATED STEAM USED FOR TEST PURPOSES

DUE TO AN ever-increasing demand for machinery and auxiliary equipment for the production, transmission and utilization of power, the Westinghouse Electric and Manufacturing Co. has for some time past realized the need for greater manufacturing facilities; but it was not until the nation's requirements for enormous quantities of ship propulsion machinery, such as turbines, condensers, reduction gears, etc., became pressing that the question of expansion could no longer be postponed. At the East Pittsburgh Works, which employ nearly 25,000 persons and which already occupy over 100 acres of ground space, no more land was available, and as a consequence it was found necessary to seek a suitable site elsewhere.

Accordingly, after due consideration of many other locations, a parcel of 500 acres was secured at Essington, or South Philadelphia, on the banks of the Delaware River, in Delaware County, Pennsylvania, nine miles south of the heart of Philadelphia, adjoining the Hog Island shipyard of the American International Cor-



poration. Two steam roads, the Philadelphia & Reading and the Pennsylvania railroads, an electric line, the Chester Short Line of the Philadelphia Rapid Transit Co. and the river afford means of transportation to and from the works; however, due to the fact that as yet no docks have been built, the waterway is at present not utilized to any extent.

In all probability the Essington plant will eventually equal if not surpass in magnitude the present East Pittsburgh Works, and it was with this prospect in mind that the Westinghouse officials provided such a large acreage. All of this, however, is not to be used for manufacturing purposes, for a town site for the homes of employes is already being established.

Light and Power Supply

At all times, considerable quantities of live, high-pressure steam are required for testing purposes, and during the heating months almost like amounts of low-pressure steam are needed to heat the various offices and shops. Utilizing low-pressure live steam for this purpose would prove undesirable, and accordingly the engineers engaged on this project decided in favor of the installation of an isolated plant, which, while furnishing steam throughout the year for testing purposes, will supply the works with electric energy only during those months the demand for low-pressure steam warrants the operation of the turbines.

During the summer months electric energy is obtained from the lines of the Philadelphia Electric Co. This is delivered at 66,000 v. three-phase 60 cycles to the outside sub-station, illustrated in Fig. 4, where by means of two banks of three each, 10 to 1 transformers connected in delta it is stepped down to 6600 v.; at this lower voltage the current is then carried through underground cables to the bus bars of the main distribution board in the power house.

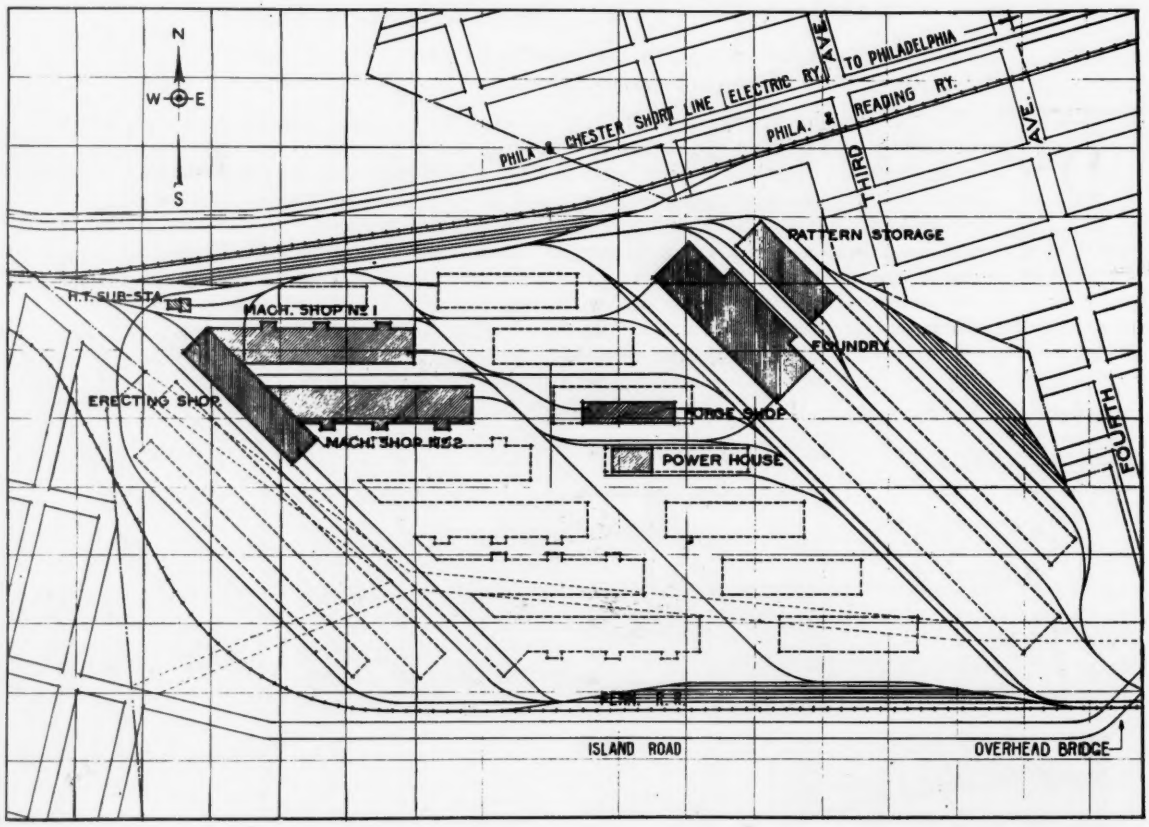


FIG. 2. PLAN VIEW SHOWING LOCATION OF VARIOUS BUILDINGS AND PROPOSED EXTENSIONS

Construction of the first building, the foundry, was commenced during the early part of April, 1917, and at the time of writing, 15 months since the place was a barren wilderness, there are seven large structures, consisting of the pattern storage and office building, the foundry, the forge shop, two machine shops, the erecting shop and the power house, with a combined floor space of about 600,000 sq. ft. Arrangements and relative location of these buildings is as shown in Figs. 2 and 3, and, as may be noted from Fig. 2, the power house has been placed with reference to the other buildings so that with the ultimate completion of the works it will be at the approximate center of gravity of the load.

The Power House

In conformity with the general scheme employed throughout the works, the power house, a substantial fireproof structure occupying a ground space of approximately 100 by 200 ft., is so constructed and ar-

ranged as not only to allow the installation of additional generating units, but also to provide extensions to either the turbine or boiler rooms at any time load conditions may require such a procedure. It is a single story building and consists essentially of the boiler room and the turbine room, each, however, with a basement below, where have been placed much of the auxiliary equipment and practically all of the steam and water piping.

Steam for the operation of the main generating units, auxiliaries, pumps, etc., and that used in the test department is furnished at a pressure of 225 lb. gage by

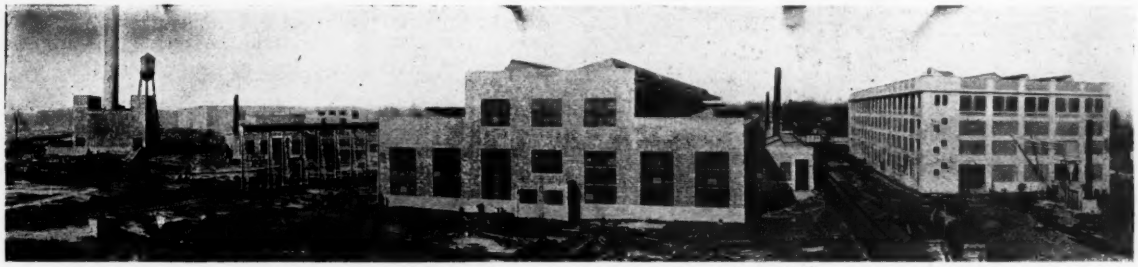


FIG. 3. GENERAL VIEW OF ESSINGTON WORKS

sists of three 1560-kv.a. 6600-v., three-phase 60-cycle Westinghouse turbo-alternators, excitation for which is six 650-hp. Stirling water-tube boilers equipped with Westinghouse automatic underfeed stokers and arranged in batteries placed back to back, thus providing wide, well-lighted and well-ventilated firing aisles along each side of the boiler room.

Stirling superheaters installed in the second pass of each boiler superheat the steam approximately 150 deg. F.

At present, the electric generating equipment con-

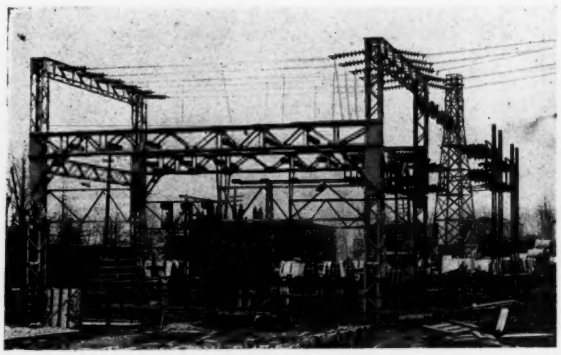


FIG. 4. HIGH-TENSION OUTDOOR SUB-STATION SERVED BY LINES OF PHILADELPHIA ELECTRIC CO.

furnished by either one of two 35-kw. exciters, one a motor-driven unit, the other turbine driven.

Room is already provided in the turbine room, as may be noted by reference to Figs. 1 and 9, for the future installation of three more main units of at least 3000 kv.a. capacity each.

The output of the plant and the energy supplied by the Philadelphia Electric Co. is controlled by and distributed from a 21-panel black slate switchboard carrying the usual complement of switches, meters and control equipment. The switchboard is illustrated in Fig. 1, and the main bus structure, which is located in the basement of the turbine room directly below the switchboard, in Fig. 8.

Fuel and Water Handling Equipment

At present coal is delivered by rail exclusively, but with further development and extensions along the river front, it will undoubtedly prove desirable to provide arrangements whereby shipments may be made by water, with transfers to the power house over the works rail system, which now interconnects all of the buildings with the main lines of the Philadelphia & Reading and the Pennsylvania railroads.

The fuel is dumped into pits, from where it is raised to the bunkers above the boilers by means of electrically-operated bucket conveyors, each of which has a capacity of 50 tons per hour. Two bunkers, one for each row of boilers, have been provided. These have capacities of 350 tons, and are built up of reinforced concrete with 10-in. side walls and sloping bottoms 8 in. in thick-

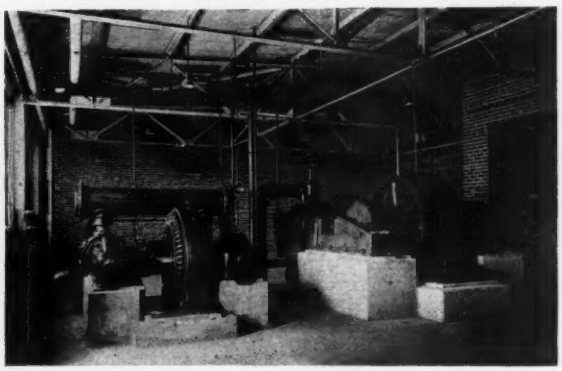


FIG. 5. MOTOR-DRIVEN AIR COMPRESSORS

ness, to which are attached the cast-iron chutes feeding the stoker hoppers.

Each bunker has an overall length of about 86 ft. and a width of approximately 17 ft.

Removal of ashes is accomplished by means of steam jet conveyors of the Green Engineering Co.'s make, and as in the case of the bunkers, two of these have been installed, one along the fronts of each row of steam generating units. After being raked into a receiving hopper, the ashes are taken up by the steam jet and discharged through an 8-in. line with riser of like size

into a storage chamber, the overall internal dimensions of which are approximately 28 by 8½ by 16½ ft. deep. From here they are removed as occasion may demand.

Products of cumbustion are cared for by a brick and tile breeching which connects with a stack having an internal diameter of 14 ft. and a height of 200 ft., a

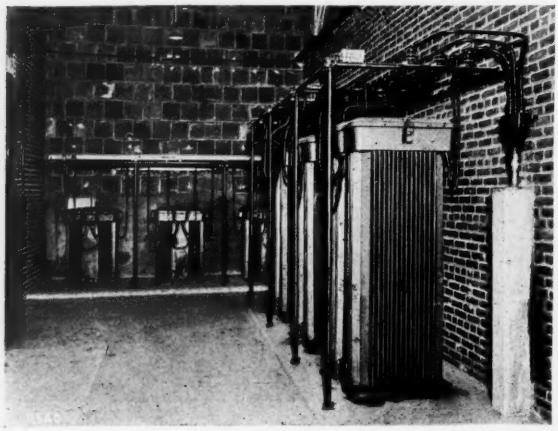


FIG. 6. INTERIOR VIEW TRANSFORMER STATION

size sufficient to care for twice the capacity of the present boiler plant.

With the arrangement of batteries and stack location employed, but a single flue was required, and as this consists of a straight run, the resistance offered to the passage of the hot flue gases is a minimum. Side walls of the breeching are built integral with the rear walls of the boilers, while roof and flooring are each constructed of a double layer of fire tiling supported by 3 by 3 by ⅜-in. tees, 10½ ft. long, spanning the passageway between the rear walls of opposite boilers. Except at the stack opening, which has dimensions of 6 ft. by 16 ft. 3 in., the internal dimensions of the

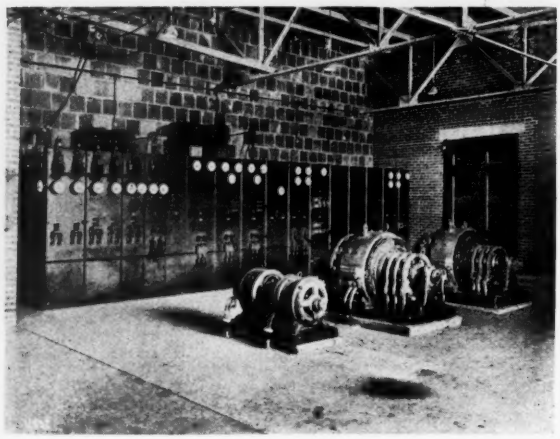


FIG. 7. INTERIOR VIEW ROTARY CONVERTER STATION

breeching are 10 ft. 4⅜ in. by 9½ ft., thus providing 0.027 sq. ft. of breeching section for each rated boiler horsepower.

Uptakes connecting the last passes of the boilers with the breeching have overall lengths of about 12½ ft., and widths of approximately 1¾ ft.; they are made of sheet metal, and to facilitate construction are provided with rounded ends.

Water used for drinking, culinary and other purposes necessitating purity is taken from the mains of the Philadelphia city water works system, while that utilized otherwise as boiler make-up and fire protection is taken from the Delaware River through a 7-ft. open canal having a surface width of 15 ft. at high tide. Mud and silt are removed by means of a concrete settling basin located between the river and the plant.

From the canal, the water is pumped into the 100,000-gal. steel service tank shown in Fig. 3 by means of a 14 by 14 by 12-in. Blake-Knowles duplex steam-operated pump which, through the agency of a pressure controller, maintains a line pressure of at least 65 lb.

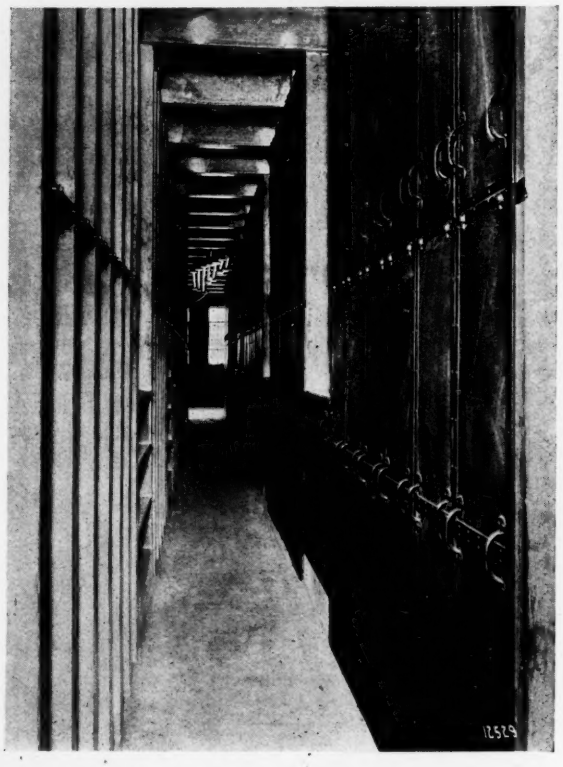


FIG. 8. POWER HOUSE BUS STRUCTURE

Leaving the service tank by gravity, the water employed for boiler feed purposes flows into a 6000-hp. Webster heater, in which its temperature is raised to 204 deg. F. From here it is taken as required and fed to the boilers by either one of two 400-gal. per minute Cameron centrifugal pumps designed to work against a head of 581 ft. and driven by and direct connected to Westinghouse steam turbines.

The discharge lines of these pumps feed into an 8-in. U-shaped main, one leg of which is fitted with a Venturi meter for the measurement of all water fed to the boilers. However, by means of properly interposed valves, this leg may be cut out of service should it become necessary to clean, repair or adjust this meter, and the water fed directly into the distribution system. This is made up entirely of 6-in. lines carried along the boiler fronts, with connecting members of like size car-

ried along the side walls, the general scheme of connections and valving being such as will allow the cutting out of service of practically any section of the system without in any way impairing the supply of water to the boilers.

Three-inch branches, each of which is equipped with a control valve of the globe type, connect the distribution main and the rear drum of the boilers.

Steam Piping

Each of the 6-in. boiler leads, which carry in addition to an ordinary shut-off valve a Foster globe type automatic stop and check valve, connect with two main 10-in. interconnected headers. One of these, as shown in the plan and elevation of the plant, Figs. 9 and 10, ties in with the 10-in. turbine room header and supplies steam to the main and auxiliary generating units, while the other through the medium of two 10-in. control valves and a 10 by 10 by 10-in. tee serves the high-pressure line leading to the test department. This line, as will be seen, is carried along the center line of the boiler room to a point within a few feet of the turbine room wall, where by means of a long radius bend its direction is changed so as to run parallel to this wall to within about 8 ft. of the outside wall of the boiler room, from where it is continued into the turbine room and then out into the tunnel leading to the test department. Before entering the tunnel lead, however, the steam is caused to pass through a 10-in. special combination globe and throttle valve electrically controlled by means of a push button system having 40 buttons installed at various points throughout the tunnel, so that in case of a broken steam pipe in the tunnel or any other accident requiring immediate shutdown, these buttons are always convenient to anyone to shut off the steam.

Test department and power house headers are interconnected so as to insure a continuous supply of steam, and where these are joined to the boiler leads drip pockets are inserted. Those used in connection with the test department main are each 10 by 4 by 10 in., while those on the power house lines are 10 by 3 by 10 in.

Turbine and fire pump leads, each of which are 6 and 5 in., respectively, in size, are similarly equipped.

Two twin pop safety valves of Consolidated make are provided for each boiler, and these, together with that with which the superheater is equipped, are interconnected in the manner shown in Fig. 10, thus allowing steam which may at any time be discharged by any of these valves to pass directly to the outside. The outlet of the superheater safety valve is piped to a short 3-in. line, which through the medium of two 45 deg. ells is in turn connected to a riser of like size, which, however, just before passing through the roof and at the point where it is joined by the boiler safety valve discharge line is increased to 5 in. As in the case of the superheater safety valve connections, all of the boiler safety valve connections are made by 45-deg. fittings, thus avoiding any abrupt changes in direction of the flow of the steam as it passes to the atmosphere.

All boiler blowoffs discharge into a 4-in. line connecting with a blow-off tank located in the basement of the boiler room and provided with an 8-in. vent extending to the roof of the building.

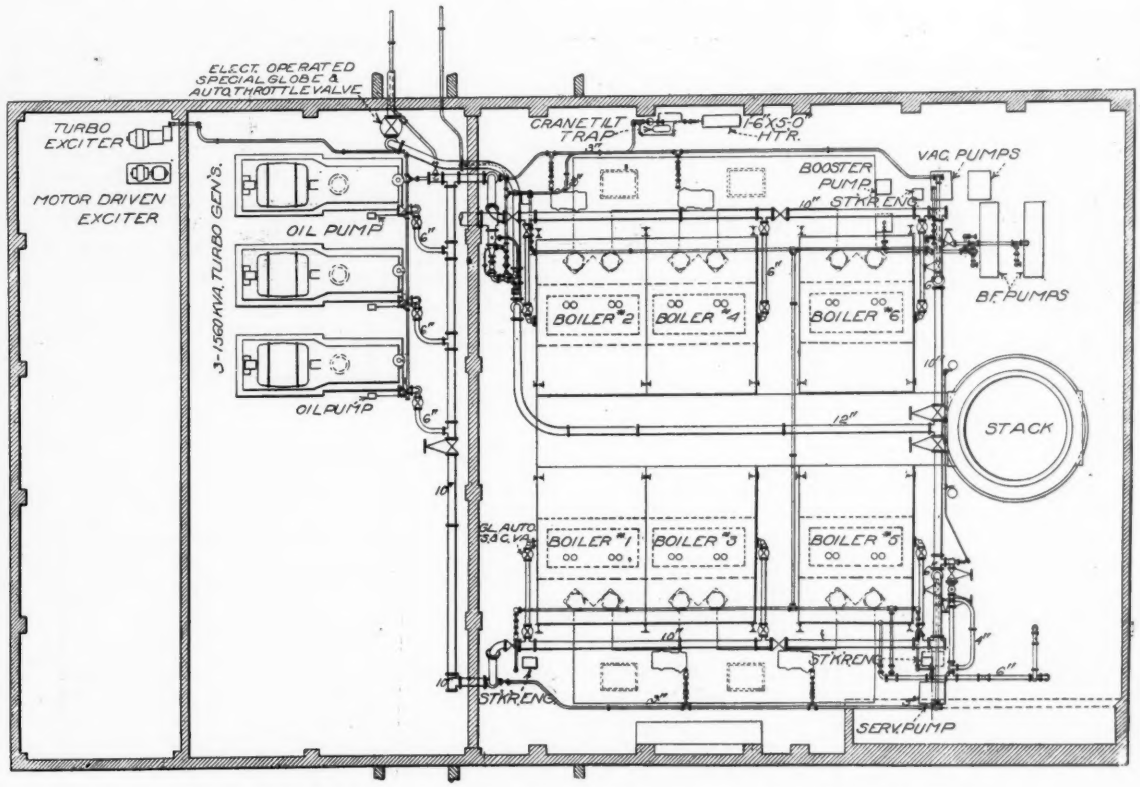


FIG. 9. GENERAL PLAN OF POWER HOUSE AND LAYOUT OF HIGH-PRESSURE PIPING

Exhaust Lines and Heating System

Due to the fact that the generating units are operated only when a demand for steam for heating exists, and that the boilers supplying live steam to the testing department are in operation throughout the year, two separate but interconnected exhaust systems have been installed.

Each of the main turbines exhausts through an 18-in. branch, carrying a shut-off valve of like size, into a 30-in. header suspended below the turbine room floor parallel to the wall separating the turbine room from the boiler room and connected at one end to the main supplying the heating system with steam. To the other end, by means of a 24-in. nipple, is tied a riser of spiral

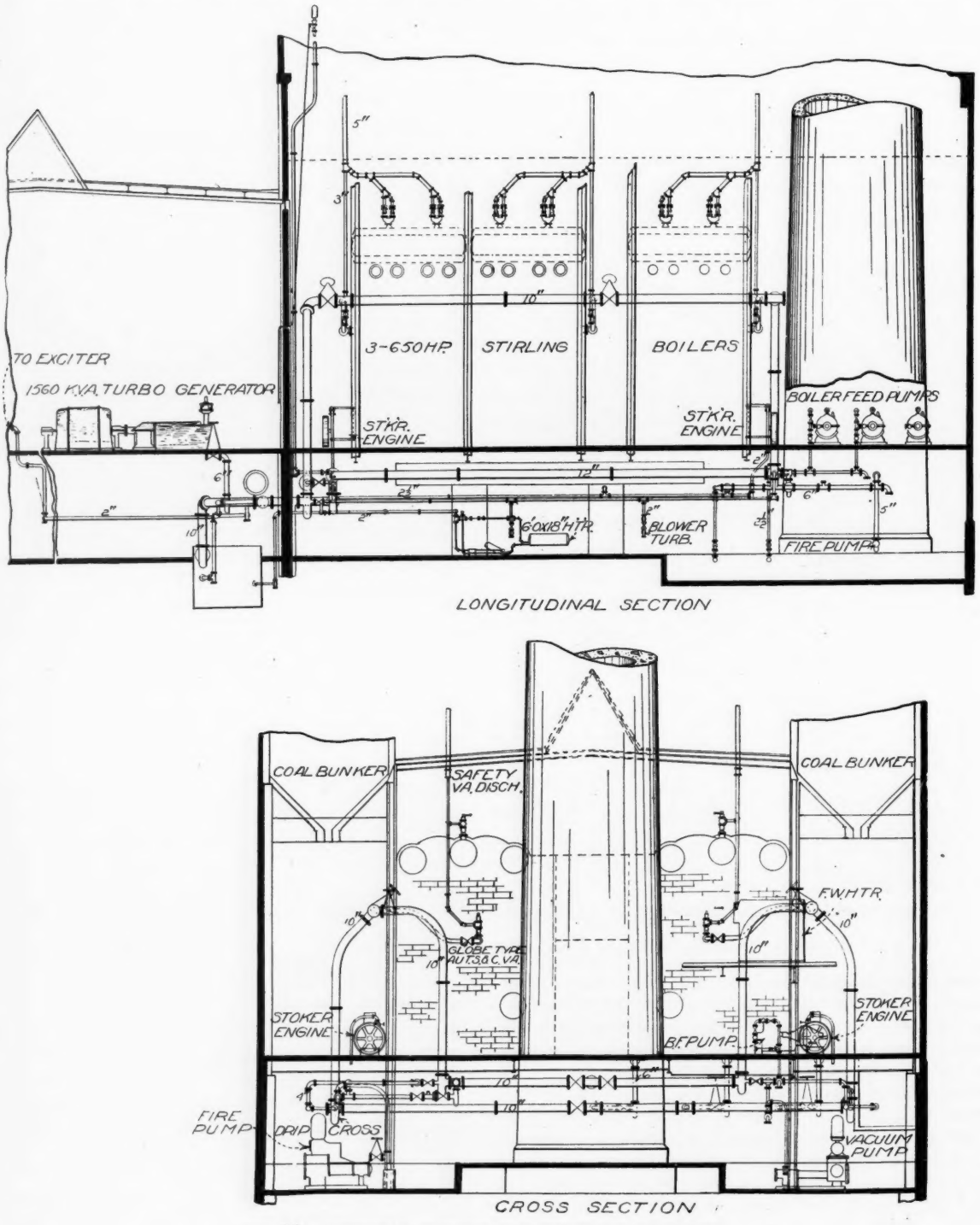


FIG. 10. SECTIONAL ELEVATIONS THROUGH BOILER ROOM

riveted pipe also 24 in. in diameter and fitted with a back pressure valve and an exhaust head, the former a few feet above the turbine room floor line and the latter directly above the roof.

The 30-in. main header also receives steam from the turbine driven exciters through an independent 5-in. line which joins the header at a point near the valve controlling the flow of steam to the heating system main.

The other exhaust system, which is connected to the turbine room header by means of a 20-in. nipple, a 20 by 12 by 12-in. reducing tee and a 12-in. gate valve, serves the various auxiliaries such as the blower turbines, the stoker engines and the boiler feed pumps. It is carried along three sides of the boiler room and consists primarily of an 8-in. main and connecting branches, the scheme of connections being, however, such as to cause all of the steam exhausted by the auxiliaries to pass through Cochrane oil separators before reaching the main. This then is tied in with a 14-in. riser of spiral pipe extending to the roof and fitted with a back-pressure valve, an exhaust head and a 14 by 14 by 18-in. tee, which, through the medium of an 18-in. line carrying a gate valve of like size, connects this riser to a Webster feed water heater, placed on a balcony in the boiler room. The heater has a rated capacity of 6000 hp. and maintains the boiler feed at an average temperature of 204 deg. F.

The fire pump is served by an independent 8-in. exhaust riser which, like the others, also terminates in an exhaust head located directly above the roof of the boiler room.

The heating system, ordinarily operating under a vacuum of 12 in., comprises approximately 50,000 sq. ft. of radiation and is served by two 24 by 24 by 14-in. Blake-Knowles duplex steam-driven pumps which discharge the condensate into a separating tank from where it is taken and delivered to the heater by means of a 10 by 14 by 16-in. duplex steam-driven pump, also of Blake-Knowles make.

Electric Distribution

Current consumed in the various shops and offices, whether taken from the lines of the Philadelphia Electric Co. or generated by the company's turbines, is delivered to the bus bars of the distribution board located in the power house. From here it is distributed at 6600 v. through underground cables to the sub-stations, of which at present there are three.

One of these, that shown in Fig. 5, and erected primarily to supply air for the operation of pneumatically-operated shop tools, is equipped with two air compressor units, an Ingersoll-Rand compressor having a rated capacity of 1000 cu. ft. of free air per minute, and a Laidlaw-Dunn-Gordon machine capable of delivering 1500 cu. ft. of free air per minute. These are driven by synchronous motors of 159 and 265 hp., respectively.

For the operation of variable speed machine tools, furnaces, blowers, cranes and other pieces of shop apparatus, a 250-v. direct-current system has been installed. This is fed by a second sub-station equipped with three 350-kw. rotary converters, and the necessary control and distribution boards. An interior view of this station is pictured in Fig. 7.

Transformers located at various points throughout the works reduce the voltage on the lighting lines from 6600 to 440, at which it is maintained for further local distribution. Transformers having winding ratios of 4 to 1, and hung on the outside walls of the building, again reduce the voltage to 110, that required for the proper operation of the lighting units.

The power load aggregates a total of approximately 2000 hp., and the lighting load, which is made up of units ranging in size from 40 to 1000 w. each, about 800 kw. for 24 hr.

Selection of the site and general direction of all activities incident to the erection and operation of the plant have been in charge of H. T. Herr, vice-president. The plant was erected by Westinghouse, Church, Kerr & Co.

Stop the Leaks and Save the Drops

THE BUREAU of Oil Conservation, of the United States Fuel Administration, makes the following suggestions on handling and burning fuel oil:

(a) When unloading tank cars, use great precaution to prevent the loss of oil when uncoupling the discharge pipe or hose.

(b) Stop all leaks in oil pipe lines, fittings, valves and storage tanks, and see that all tank openings are kept closed. Storage tanks should be equipped with steam-heating coils.

(c) Install efficient burners. Homemade burners are usually crude and consume an excess of oil.

(d) Install strainers. Dirty oil clogs the burner, slows up heating operations and increases fuel consumption.

(e) Install duplicate pumping system, and pump the oil to the burners under a uniform and constant pressure.

(f) Install suitable preheaters, in order to obtain proper atomization, clean combustion and prevent the formation of carbon. This is especially necessary with heavier gravity oils.

(g) Use pyrometers in all heating and heat-treating furnaces. The operator may have good eyesight, but he cannot always judge heat by color. If there is a higher temperature than necessary, fuel is being wasted.

(h) Impress upon furnace operators the necessity of conserving fuel by keeping their furnaces and equipment in the best condition possible, in order to obtain the maximum of economical efficiency.

(i) Install oil meters, thus enabling you to keep a record of daily consumption, and compare it with previous data and note the decrease in the amount used.

(j) Have sufficient oil storage capacity, otherwise you may have to shut down because your oil shipments are delayed and supply exhausted. Shutdowns mean a loss of heat and added fuel consumption.

(k) Operate furnaces 24 hr. a day when possible.

For a condenser whose tubes are clogged with hard scale, a solution of equal parts muriatic acid and water allowed to stand in the water space for about 8 hr. or until bubbling ceased, has been found effective in removing the incrustation. The shell must be vented during the process, and inlet and outlet for cooling water closed.

Power Plants and the Fuel Situation

THE ADMINISTRATION'S ATTITUDE TOWARD AMOUNT OF COAL TO BE SECURED, STORAGE, USE OF EXHAUST, AND REFRIGERATION. BY A. P. CONNOR, WASHINGTON CORRESPONDENT

VARIOUS specific phases of the fuel situation will touch closely the various kinds and sizes of power plants according to the conditions. Exactly what will happen in any case cannot be specifically stated at this time, but we are assured that something will be done where needed. Some of the phases of the subject are here outlined for general guidance, and are based on investigation of the various bodies dealing with the fuel situation.

How Much Coal Can Be Acquired

AFTER finding out the source and arrangements for the procuring of coal, the user is faced with the question, how much he can acquire and hold. At the present time there appears to be no limit set. If a power plant needs 100 t. of coal to run it through a season, it will, normally, be allowed to have that amount, and its policy should be to seek to obtain that amount now. If a plant under such conditions seeks to obtain a larger supply than its normal needs require, as, for instance, 150 t. where 100 t. is enough, that policy will be considered hoarding and render the plant liable for the consequences possible. As a matter of fact, the policy of the Fuel Administration is to force the plants to be more economical and efficient than they have been in the past and to cause them by necessity to make 60 t. of coal serve where 100 t. was used heretofore.

Realizing that the War is the item of first consequence at present, it is the intention of the Fuel Administration to follow closely that principle. It will analyze the conditions in all cases and will tend to increase the supply of fuel to power plants having "essential-to-war industries" dependent on them for power, decreasing substantially the amount for those plants supplying industries defined as "nonessential," during the war period. It may, therefore, be expedient for power plants having special desire to keep going at full blast, to have their industrial consumers particularly occupied with the production of material that will assist in the prosecution of the war and its aims. There appears to be no harm in acquiring as much coal as possible, if a power plant has storage for it, as the Fuel Administration will superintend its use and apportion to other plants any surplus in one plant.

The principle involved in judging a specific case as to how much coal should be acquired depends on: (1) the normal amount required; (2) the industrial use for which it is intended; (3) the storage facilities, and (4) its location relative to transportation means. Suitable balancing of these elements will give a good idea as to what will be permitted to the fuel user.

Storage of Fuel

IN SOME CASES, the question will arise as to what individual amount of storage is anticipated by the Fuel Administration. This is one largely up to each power plant to decide for itself. The Fuel Administration appears to have its hands full enough, without deciding this specific problem for individual plants.

The power plant that must lay in a supply of coal for its needs would do well to make its own decision. If regular storage facilities are not ample, it would be well to acquire a place for special storage, and fill it with coal, now. It is not difficult, in most localities, to rent property and store coal in it at a nominal cost. Even in large cities where land may be expensive, but where vacant lots exist, it may be possible to use these vacant lots, even if the owner has objections to renting them, provided the proper assistance of the officials in charge can be enlisted to provide for such use. Every plant should utilize all the storage space available for fuel within its boundaries, and this will, in most cases, be found to be much greater than is made use of in normal times.

Those who are in such extremity that they are entirely dependent on the good-will of the Fuel Administration, for storage, should see to it that positive relief is provided for without delay. The Fuel Administration appears to be taken up at present with the problems of getting a good supply of coal to everybody at this time, and it is, therefore, good policy for individual plants to provide their own storage by any means within their power, and leave the question of "use" to the later action of the Fuel Administration. There is, however, one point to be kept in mind, and that is, storage that causes inefficiency in the use of the coal will not be tolerated, but otherwise the storage will be permitted to its maximum, that is feasible and desirable.

Apportionment of Coal for Heating and Power

HOW MUCH fuel will be allowed for heating and how much for power purposes, is a complicated question and cannot be answered generally. The Fuel Administration seeks to save fuel by preventing unnecessary wastes in the use of fuel. It will not radically shut down a plant without good reason and without a benefit being attached to such action. It is reaching out to reduce excessive heating of office buildings, apartment houses and the like, and is more or less enforcing a standard temperature for such places that will not exceed that necessary to keep people comfortable. Sixty-eight degrees F. is the temperature generally recommended, and should not be exceeded. This standard of heating will have an important place in the apportionment of fuel for heating. Another question will be the reduction of space to be heated; thus all rooms not used continuously will be compelled to limit their heating, and every place where economy can be practiced will provide a limited heating. The question of essential uses of buildings for the aims of the war may also be brought up in the matter of heating, and particularly on certain fuelless days that may be selected, if it is ultimately deemed proper to order them.

In the matter of power, where choice seems possible between power and heating, the question will generally be decided in favor of what appears to be more beneficial to the general comfort and health of the people. Where power goes into lighting, and that of a display nature, as against that of necessary use, there will be less freedom in the use of fuel. There will be the so-

called lightless nights for the rest of the war period, unless a special and unexpected ample surplus of fuel should be placed at the disposal of the users, a condition that seems remote, at this time. In this general way, the apportionment of fuel between heating and power users will be distributed, unless it should be found out that a more definite and specific apportionment can be arranged.

Exhaust Steam Heating

Through Charles E. Stuart, Chief of the Power and Light Division, the Fuel Administration has outlined its views in general. It has announced radical objection to isolated plants, on the assumption that such plants consume four times as much fuel per unit of electrical energy generated as do the central stations. From the point of view of saving fuel, the Administration desires the utilization of central station facilities, especially during the summer months, when practically no steam is needed for heating. But it has no sentiment in favor of the central station as against the individual plant, and has broached the idea that it will take steps to protect the users of central power against high prices, if order is issued to shut down individual plants.

Authorities look with favor on the use of exhaust steam for heating, and want to see every B.t.u. made useful.

Classification of Power Plants

This will follow two general lines: relative efficiency and economy; and essentiality to war work. Every plant will be subject to close investigation and inspection, at the start, but later those found using all facilities for economy may be relieved of inspection where no good object is served by continuing it.

The general lines that will be followed in classifying are as follows: Can the plant be eliminated and use central station current with a saving in fuel cost and labor? Can a plant be shut down for a period, resulting in saving, and causing practically no inconvenience? Is a central power plant being run so that its use of fuel is more than that required for a number of isolated plants that are available? Thus it is possible that a central power plant may be shut down by the Fuel Administration, and a manufacturing installation left running if it is in the interest of the war to do so and results in a saving of fuel. It may happen that a central power station may be shut down and isolated plants be called upon to handle that load, if by doing so economy will result. It may also happen that a central power station may be shut down, as far as the generating of power within its own walls is concerned, and its buses connected to another plant, such as a hydraulic installation, if it is feasible and economical to do so, leaving the power plant in potential existence, in case it is required to operate, but preventing it from operating when unnecessary use of fuel will result. There may be a very comprehensive interconnection of power plants brought about, if it is decided that it is necessary, and that may be done without regard to the financial benefits or losses of individual power plants in the matter. Thus the Fuel Administration will not encourage a water power plant using only fifty per cent of its available capacity, and a power plant using fuel developing 100 per cent capacity, where the water power plant can be made to take its full load and decrease the load on the fuel using plant, so as to reduce the use of fuel. It may, therefore, be expected that water power plants will in the near future be compelled to develop their maximum output and at the expense of as many fuel-using power plants as possible. If two central power plants are acting in competition in the same locality, it is likely that one of them will be shut down and the whole load put on one plant, for the time being, if such action makes a saving.

Economies Ordered

The Fuel Administration, while possessed of almost unlimited powers, apparently seeks a line of action that is fair. It has not acted thoughtlessly, in spite of the short time of its experience and existence. Of course, some of its orders have radically affected certain interests, but these have been confined to certain classes. The lightless nights caused great financial loss to central stations. The Monday closings were universally felt. The brewery interests have been stricken hard, and so on, but in spite of this drastic course, there seems to be a feeling throughout the country that the burden is not unbearable, and in most cases most of the interests affected by the orders are making money in other ways that amply cover the inconvenience and cost of these orders, and the making of the money is frequently due to the war.

A saving action on the part of the Fuel Administration that bespeaks its intelligence, is in the establishment and enforcement of a clean coal order. If your coal is poor in quality and is transported by public facilities, the Fuel Administration will fearlessly and adequately come to your relief, when its attention is called to the matter. The early ordering of coal campaign is also a most practical assistance to the community in every respect. And its other actions have been, on the whole, on the best lines.

The fuel Administration has made suggestions resulting in slight changes in our conventional life, but making vital savings in fuel. It has urged the skip-stop on car lines in the cities throughout the country, which means that the number of stops for street cars has been reduced so that a stop of the car will be made "worthwhile" as much as possible. It has urged the elimination of perpetually burning lights, where such are of little actual use, especially during the day time. And what is perhaps the most convincing feature is the fact that the Fuel Administration appears to have made every attempt to keep its own offices and buildings consistently following its own principles.

Refrigerating Plants

Not satisfied with saving heat, the Fuel Administration has gone into the realm of saving "cold" if such a statement can be made. It has called the attention of makers of ice to the desirability of eliminating the agitating processes of making raw-water ice transparent, and making in its stead the white or opaque ice, at a saving of from 10 to 15 per cent in fuel or power, it is claimed.

It also proposes to shift industry so that it will be

placed where power is available at the greatest saving in fuel; and also to cause an elimination of what it considers unnecessary plants, where there are too many, carrying too light a load.

There are yet a number of economies that the Fuel Administration has not touched upon, which, however, is not to its discredit, as it is but completing its first year of existence and in that time has laid foundation for great progress to the ultimate benefit of the country, if its principles are adhered to properly, which there appears every reason to believe will be done, by its present personnel. We are, however, alive to the fact that the matter of economy is a delicate matter, which if not handled with the greatest skill and tact will bring about a most unsatisfactory condition, without any adequate benefits to offset it. And future actions will be watched with great care and no little anxiety.

In the matter of economies, many somewhat spectacular moves have been made, which, while not making a saving that might be appreciated technically, seem to have caused the people to give more attention to the matter than they anticipated was needed. There are savings which can be made everywhere that are more apparent to the observer than the particular lines taken; there is, for instance, a possibility of saving by the lighting of certain cities at a later hour than is now used; in fact, in the majority of cases, the street lighting could be delayed one-half hour without the slightest inconvenience. The putting out of lights in the morning is usually done at the earliest feasible moment. The use of waste products as fuel could be given more attention by many factories; and the cutting down of the use of coal unnecessarily burnt for domestic purposes would tend to improve conditions in the manner desired by the Government at this period. It is, however, understood that all these phases are being considered, and many more, and much interesting information is expected to be promulgated at a later date in connection with the matter.

Co-Operation

There is one unfortunate condition at present: lack of united action among those interested in power plants. Their main protection is really in the power engineering magazines to keep awake and openminded.

The man who is technically qualified is being placed in his proper place for action, and the man who knows his business, not only practically but technically, will be selected for the important positions that are to come in the future. It is not a question as to whether the practical man or the technical man is the better, but it is the man who is well qualified in both ways that will be in demand. The opportunities for the acquiring of all possible information on all phases of power plant engineering are great at this time, and should be made full use of by those who have to stay at home to win this war. There is no time for economy in the line of technical training. If it requires an outlay of money for books or periodicals it should be cheerfully made, as the information they impart is based on the results of experiences costing oftentimes thousands of dollars. If night classes in engineering are available they should be used to their limit, but the best general course is that obtained by the reading and understanding of good power plant engineering magazines, as they keep up-to-date with the latest practice. It is advantageous for engineers to get fully acquainted with the newer types of prime movers, if their plants do not have them, and this through use of text books explaining in detail the principles of these new prime movers. The catalogs of up-to-date manufacturers of power plant apparatus give much valuable information and are almost universally obtainable for the asking; the engineer should avail himself of the opportunity of getting all such catalogs, even if his plant has no immediate use for apparatus.

Bonds of the First and Second Liberty loans may now and until Nov. 9, 1918, be converted into 4¼ per cent bonds. Bonds delivered upon conversion will have the same maturity as the bonds surrendered. In all other respects they will be identical with the bonds of the Third Liberty Loan. This conversion may be effected through the subscriber's bank.

Holders of 4 per cent bonds of the First Liberty Loan Converted, presenting them for conversion on or before Nov. 9, 1918, will receive in exchange, without an adjustment of interest, 4¼ per cent Gold Bonds of 1932-47, bearing interest at the increased rate from June 15, 1918.

Holders of 4 per cent bonds of the Second Liberty Loan, presenting them for conversion on or before Nov. 9, 1918, will receive in exchange, without an adjustment of interest, 4¼ per cent Gold Bonds of 1927-42, bearing interest at the increased rate from May 15, 1918.

Holders of Coupon bonds may receive at their option either Coupon bonds or Registered bonds; but Registered bonds only will be delivered upon conversion of registered bonds, and such bonds will be registered only in the same name as the bonds surrendered for conversion. When Registered bonds are presented for conversion, they should be assigned to "The Secretary of the Treasury for Conversion," on the form appearing on the backs of Registered bonds. Such assignments, however, need not be witnessed.

All unmatured coupons must be attached to the bonds presented for conversion, and all matured coupons must be detached.

Holders of 3½ per cent bonds of the First Liberty Loan, presenting them for conversion on or before Nov. 9, 1918, will receive in exchange 4¼ per cent Gold Bonds of 1932-47, bearing interest at the increased rate from June 15, 1918, but such holders must pay the United States Government accrued interest at the rate of ¾ of 1 per cent per annum from June 15, 1918, to the date of conversion.

The conversion privilege on 4 per cent bonds of both the First and Second Liberty Loans expires on Nov. 9, 1918, and they cannot be converted into subsequent issues of United States bonds which might come out at a higher rate. Therefore, holders of 4 per cent Liberty Loan Bonds should in every case present them for conversion. By converting these bonds they will not only receive ¼ of 1 per cent additional interest, but after the conversion period has expired (Nov. 9, 1918) there will undoubtedly be several points difference in the market price of the 4 per cent and 4¼ per cent bonds.

Coal Required for Heating

METHOD OF PREDETERMINING COAL REQUIREMENTS BASED ON THE AVERAGE TEMPERATUDES AND MODERN EQUIPMENT. BY M. WILLIAM EHRLICH

ARE you using too much fuel for the service delivered? Is the coal bill really high? These serious questions can be answered. The coal requirements for the service, however, must first be known. Do you know what your heating costs? The difference between the cost as it should be and the cost as it is may be taken as a measure of heating plant economy.

With many shops and factories operating 24 hr. a day, it is very important that an adequate temperature be maintained in the working space. This condition is dependent on the useful heat given up by the coal burned on the grates under the boilers to provide the required steam delivery. The worker must have comfortable conditions or the manufacturer must suffer the consequence—a loss in output. It so happens that nature will have her way. So, after midnight and during the early hours of the morning, low temperatures often prevail. During the daytime the cold is not so severe.

It is because of these weather conditions that heat must be supplied continuously for building interiors,

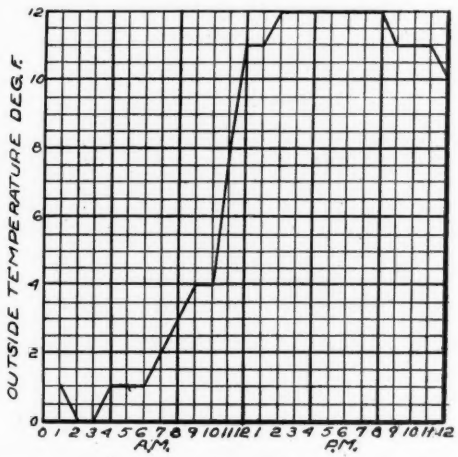


FIG. 1. HOURLY TEMPERATURE FLUCTUATIONS DURING A COLD DAY WHICH REPRESENT THE PROPORTIONATE TAX ON THE HEATING SYSTEM

at least during the hours of occupancy. A temperature of 70 deg. indoors has become recognized as a condition of comfort. While this temperature is held practically constant indoors, the outside temperature fluctuates to a greater or smaller degree, depending on geographical location. It is the difference between the prevailing outdoor temperatures and the inside work space temperature that is the real measure of coal consumption for a heating system of any size operating any number of hours. The heating season has an average duration of seven months, more or less, according to the weather conditions of a given locality. Usually the heating season starts some time in October and terminates some time the following April. Therefore to determine what the coal consumption should be for heating a building these variables must be known. In this respect the records of local weather bureaus are of real value and importance.

When the heating installation is first designed and proportioned for the factory, average conditions, not extremes, are taken as a basis. This average, however, is of the minimum temperatures of the locality, and therefore represents the designed maximum condition of heating as determined by the temperature difference. A common standard is to figure on zero weather outdoors and 70 deg. indoors, which is a temperature difference of 70 deg. Where the same indoor temperature is to be maintained, and the average minimum out of doors is 10 below zero (—10 deg.), the difference is, therefore, 80 deg. Likewise with —5 deg. outside and 65 deg.

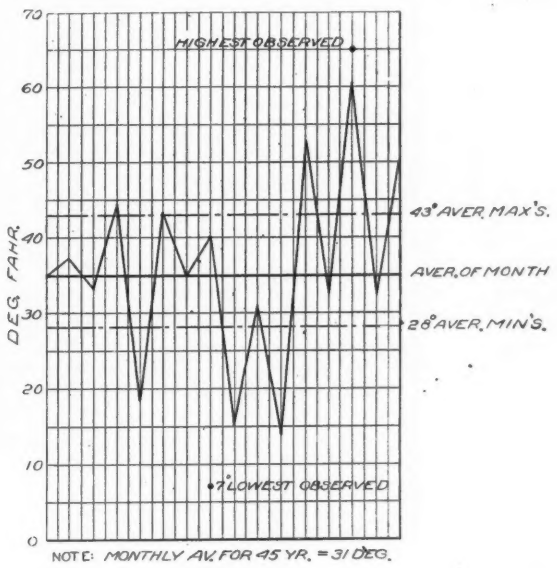


FIG. 2. GENERAL FLUCTUATIONS OF DAILY MEAN TEMPERATURE FOR JANUARY, 1916

indoors, the temperature difference is 70 deg., and so on for other conditions.

AVERAGE TEMPERATURES

WHAT MAY be expected on an average severe day, under conditions where zero is considered the minimum, is indicated in Fig. 1. This diagram shows the hourly temperature variations, reaching zero about 2 a. m., lasting to 3 o'clock, and then gradually rising until 11 deg. is reached at noontime. There is still more of a let-up, and 12 deg. prevails during the afternoon, decreasing after 8 p. m. to 10 deg. at midnight. Now then, when it is zero outdoors and 70 deg. inside, the designed maximum condition obtains and the heating system is taxed to capacity. When it is 10 deg. outside and 70 indoors, then the temperature difference is 70 minus 10, or 60 deg., which is therefore 60/70 of the established maximum heating tax. It is seen, then, that with a set temperature indoors, the tax on the system

is highest when the outside temperature is the lowest, and vice-versa.

These relative values must be thoroughly understood in order to grasp clearly the conditions that make for a greater or smaller coal consumption. The relation is always between the prevailing temperatures and the maximum condition for which the heating system was designed. As averages are dealt with entirely, it may prove of interest to observe the temperature variations from day to day, for these values determine the average demand for the month. Taking the records of New York City for illustration, the diagram Fig. 2 has been prepared. This shows the January weather variations for 1916. The average of the month was about 35 deg., while the average of minimum temperatures was 28 deg. and of maximums 43 deg. During that month the lowest observed was 7 deg., while the highest temperature reached 66 deg. In face of these facts the average for the same month over a stretch of 45 yr. is but 31 deg.

What these averages are for different localities has been compiled for convenient reference from the records of The Weather Bureau, U. S. Department of Agriculture, and are shown in the tabulation herewith. The lowest observed, which is the extreme minimum temperature, is given in the first column, while the averages for the 7 mo. of the heating season make up the body of this tabulation. The average for the season is given in the last column. It should be observed, as in the case of Chicago, that while the lowest observed temperature is —23, or 23 deg. below zero, the average minimum that designers figure on when proportioning a heating system is only —10. For New York, the extreme temperature is given as —6, while heating engineers proportion all installations for this locality on an average of zero. Similar practice is in vogue in the various sections of the country.

Graphic Calculation of Coal Requirements

With this much established, a basis for computing the probable coal consumption for low-pressure steam heating installations using direct radiation is available. However, the calculation is complex and involves many variable factors. To obviate the necessity of extensive figuring, the chart shown in Fig. 3 has been prepared for convenient solution of the problem. The results it gives closely approximate actual conditions of fair operation because the human factor and other variables involved have been taken into account.

In the use of this chart there is nothing left to be assumed, all the values required are taken from the actual installation and operating conditions, and the results found by direct-reading. The hours of operation must be known for a week, month or the entire season, as may be desired, and this means the hours in which steam is used for heating in that period. The square feet of direct radiation may be obtained from the installation records or by adding together the surfaces of the heating units located throughout the plant. The other value that must be known is the average demand on the system, which is a factor corresponding to the weather conditions.

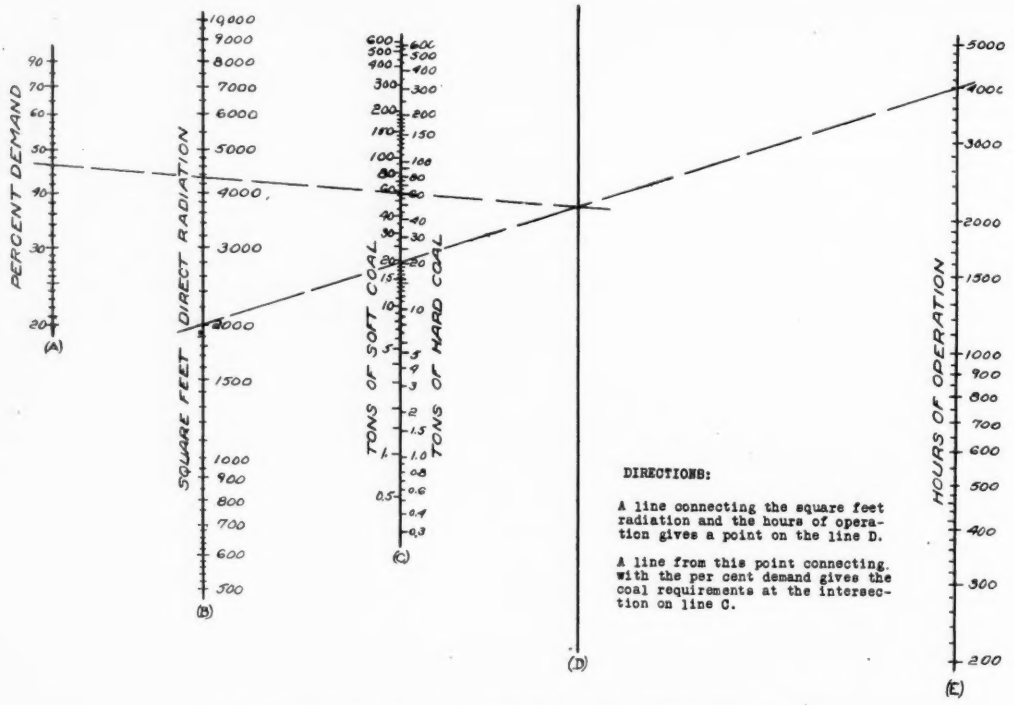

PERCENT DEMAND
SQUARE FEET DIRECT RADIATION
TONS OF SOFT COAL
TONS OF HARD COAL
HOURS OF OPERATION
(A)
(B)
(C)
(D)
(E)
DIRECTIONS:
A line connecting the square feet radiation and the hours of operation gives a point on the line D.
A line from this point connecting with the per cent demand gives the coal requirements at the intersection on line C.

FIG. 3. CHART OF COAL REQUIREMENTS FOR STEAM HEATING

For illustration, consider a factory system of heating which is made up of 2000 sq. ft. direct radiation. The weather variations are such that the average condition is a demand of 46 per cent. How many tons of coal does this system require for 4000 hr. operation?

Answer: On the scale of line B, in Fig. 3, find 2000 sq. ft. radiation. On line E find 4000 hr. Then lay a

rule or straight-edge across to connect these two values, as indicated, and there will be an intersection on line D. Then find 46 per cent on scale A, and connect this, by means of a straight-edge, with the point of intersection found on line D. Where this new line, as shown, intersects the line C the answer is found at that point. In this case the answer as found on the scales of line C is about 60 tons of hard coal or 57 tons of soft coal that will be required to give adequate heating service.

In the same simple manner all coal problems for steam heating may be solved with the aid of the chart. It is important that the per cent of demand agree with the period or hours of operation, otherwise misleading results will be obtained. For instance, when it is desired to find the coal consumption for a month's heating service, the demand on the system must be based on the weather conditions for that particular month. The same holds true for the total coal requirements for the entire season. In this connection the averages of temperatures over a range of 33 yr., as given in the tabulation, will be found a valuable aid.

To determine what this heating demand is, in per cent, the average temperature for the period under

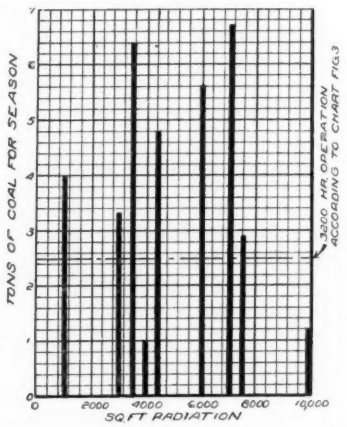


FIG. 4. ACTUAL RECORDS OF NEW YORK AND CHICAGO BUILDINGS USING BOTH ANTHRACITE AND BITUMINOUS COAL SHOWING COAL REQUIREMENTS PER 100 SQ. FT. RADIATION

consideration is subtracted from the indoor temperature, and the result is divided by the maximum temperature difference used in proportioning the radiation.

Consider a condition of 70 deg. maintained indoors and a maximum difference in temperature from —10 to 70, or a total of 80 deg. This corresponds to Chicago weather, where, say, for December, the average outdoor temperature is 29 deg., as in the tabulation. Then 70 less 29 is 41, and this divided by 80 gives a demand for the month of about 51.2 per cent.

Take another example. This is a shop where 65 deg. is sufficient for heating the interior. The maximum temperature is from —5 to 65, which is 70 deg. This plant is located where the average weather for the heating season is 35 deg. Then 65 less 35 is 30, and divided by 70 gives an average demand of about 42.3 per cent. This same method of computation applies to all conditions, and the result thus found is the value to use on scale A of the chart in Fig. 3.

By a close study of this diagram, deductions will show that for any given condition 2 sq. ft. direct steam radiation operated for one-half hour will require the same amount of coal as 1 sq. ft. radiation supplied with steam for one hour.

From these observations it should be clear why two buildings, similarly arranged, require different quantities of coal to do the necessary heating. In one case, 50 tons of coal may be burned, and with equal care the other building consumes 60 tons. This is no comparison because neither the temperature conditions nor the hours of operation are stipulated. Such "comparisons" are misleading as well as erroneous. A close approximation of what any steam heating system requires in the way of coal may be had by the use of the chart, as outlined. Then if the plant consumes more coal than indicated by Fig. 3 for that condition, obviously a source of waste exists. Investigation will probably disclose the leak. If such examination and consideration of the conditions do not account for the waste, then an expert should be consulted. It pays to stop such loss—and it

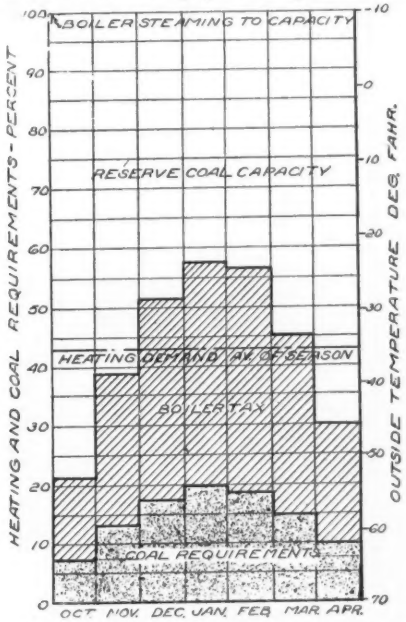

BOILER STEAMING TO CAPACITY
RESERVE COAL CAPACITY
HEATING DEMAND AV. OF SEASON
BOILER TAX
COAL REQUIREMENTS
HEATING AND COAL REQUIREMENTS - PERCENT
OUTSIDE TEMPERATURE DEG. FAHR.
OCT. NOV. DEC. JAN. FEB. MAR. APR.

FIG. 5. MONTHLY COAL REQUIREMENTS AND DEMAND ON BOILER CAPACITY TO MEET CHICAGO WEATHER CONDITIONS

can be stopped. Most coal waste is avoidable and preventable.

Heating and Power Plants

In the case of a combined heating and steam power or electric plant, the same considerations apply. The amount of coal required for the heating service still remains the same. That is the very feature which often makes a power plant a good investment. When the total amount of coal used for all services is known, then it is only necessary to subtract from this the coal requirements for heating. The result will show whether economy is practiced or whether some preventable loss exists.

It is unfortunate that so much coal is wasted annually. There are many causes responsible for this condition, and most of them can be removed. As an illustration of such waste, Fig. 4 is presented. In this

diagram several instances of actual operating conditions are shown graphically. The values represent the tons of coal required to supply the necessary steam to 100 sq. ft. of radiation during the heating season. In one case, one ton did the work, while in another building 6.8 t. of coal were consumed. These are both extremes of economical and wasteful operation, respectively. These values cannot be used for purpose of specific comparison because the length of the heating season is not specified in terms of hours. According to the values in Fig. 3, however, for similar conditions an average of 2.5 t. of coal should adequately heat 100 sq. ft. radiation for 3200 hr.

In modern factory buildings, usually more economical conditions obtain. The average of fair operation is, however, represented by the direct-reading chart, Fig. 3. When a competent fireman attends the boiler fires, and mixes a little brain with the fuel, less coal will be required than otherwise. This human factor is one of the deciding elements that either make or mar the economy of a plant.

Monthly Requirements

To the alert manager the data presented has further advantage, in that it can be used as a monthly guide on coal consumption. For any particular condition of plant operation, a diagram similar to Fig. 5 may be prepared for ready reference. The basis for this chart is found in the tabulation giving the average weather conditions for different localities. Take a Chicago plant as an illustration of the method employed. The indoor temperature for the heating season will be approximately 70 deg. The maximum temperature difference is 80 deg. According to the tabulation, the outdoor temperature for October averages 53 deg. The difference between this and room temperature is 70 less 53, or 17 deg. For January the outside average is 24 deg., and the difference is therefore 46 deg. Taking these differences month by month, and adding them, gives a total for the heating season which may be taken as 100 per cent. The total in this case will be found to be 240. Then 17 divided by 240 gives 7.1 per cent for October. Likewise for January it is 46 divided by 240, which gives 19.2 per cent. These percentages represent the coal requirements for the periods mentioned as compared with the total for the season. Thus if 100 t. of coal are required for heating purposes during the season, then 19.2 t. would be consumed during the month of January. These values for the seven months of heating in Chicago have been computed as above and plotted in Fig. 5.

AVERAGE MONTHLY OUTDOOR TEMPERATURES FOR 33-YR. PERIOD

Locality	Lowest Observed	Monthly Temperatures							Aver. of Season
		Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	
Albany, N.Y.	-24	50	38	28	22	24	32	46	34.3
Amarillo, Tex.	-16	56	44	36	34	37	45	56	43.9
Atlanta, Ga.	-8	62	52	45	42	45	52	61	51.3
Bismarck, N. Dak.	-44	44	26	15	7	8	22	43	23.6
Boise, Idaho.	-28	50	40	32	29	34	42	50	39.6
Boston, Mass.	-13	52	41	32	27	28	36	48	37.1
Chicago, Ill.	-23	53	39	29	24	25	34	46	35.7
Cleveland, Ohio.	-17	53	40	31	26	27	34	46	36.7
Des Moines, Iowa.	-30	52	37	26	20	24	36	51	35.1
Green Bay, Wis.	-36	47	32	21	15	17	27	41	28.6
Harrisburg, Pa.	-14	54	42	33	29	30	38	51	39.6
Indianapolis, Ind.	-25	55	42	33	28	31	40	52	40.1
Kansas City, Mo.	-22	56	42	32	26	30	41	54	40.1
Knoxville, Tenn.	-16	58	47	40	36	41	48	57	47.0
Little Rock, Ark.	-12	63	52	44	41	44	53	63	51.4
Louisville, Ky.	-20	58	46	38	34	37	45	56	44.8
New Orleans, La.	7	70	61	54	53	56	62	69	60.5
New York, N.Y.	-6	56	44	34	30	31	38	48	40.1
Oswego, N.Y.	-23	51	39	29	24	24	31	45	34.4
Port Huron, Mich.	-25	50	37	27	22	23	30	42	32.9
Portland, Ore.	-2	53	46	41	39	41	46	51	45.5
St. Paul, Minn.	-41	48	31	19	12	15	28	46	28.4
Salt Lake City, Utah.	-20	52	40	32	29	33	41	50	39.6
Washington, D.C.	-15	57	45	36	33	34	42	53	42.9

Having determined the average differences in temperature for each month, it is only necessary to divide these by the maximum temperature difference, which in this case is 80 deg. for Chicago. The result will show the relative tax on the steaming capacity of the boiler for heating purposes. Thus for October it is 17 divided by 80, which is 21.2 per cent, and for January it is 46 divided by 80, which is 57.5 per cent. Plotting these values for each month of the heating season, as in Fig. 5, gives at a glance the required information as to the steam demand or heating tax on the boiler plant. Interest and value is added to such diagram by plotting the outside temperatures to correspond with the scale of per cent. The minimum temperature, as shown, is the equivalent of 100 per cent and the constant indoor temperature is equal to zero, which means that no steam or coal is required—the boilers may be idle.

Such a diagram gives at a glance a means of checking the monthly coal consumption of the heating system. Only by keeping close track of operation can leaks be prevented. Pre-determine your coal requirements, watch the actual coal usage and keep down costs. Do your bit, conserve the fuel supply—and profit by it.

Fuel Engineers Wanted

The Fuel Administration for Illinois desires to have a complete list of engineers familiar with combustion problems, who are in a position to render consulting service to power plant owners and operators and to whom these people could be referred in case they should desire to employ such a consulting engineer.

It is not the first function of the Administrative Engineer to perform this service, and he desires to be in a position to give plant owners a list of consulting combustion engineers, from which list they could select one to do their work. This, of course, would be paid service, and no partiality will be shown in presenting this list. Those who desire their names included in such a reference list should send names and addresses and an outline of experience to Joseph Harrington, Administrative Engineer, 120 W. Adams St., Chicago, Ill.

Statements which are being made in some quarters that there will soon be less need for conserving wheat will hardly bear analysis. While the early harvest was good, the outlook for spring wheat is not of the best. South Dakota reports favorably, but crops in other wheat growing states are doubtful owing to dry weather and cold during early summer. In addition, the potato acreage in the west is less than in 1917, due to low prices, and the need of wheat for allies in Europe is greater than last year because a smaller force is available for cultivating crops.

While there may be some slackening in the stringency, there is little likelihood of any material modification of the requirements for wheat conservation for a long time yet.

Improving Engine Economy—II

INCREASING THE EFFICIENCY AND CAPACITY OF ENGINES BY GIVING PROPER ATTENTION TO THE STEAM SUPPLY. BY M. A. SALLER

WHILE THE investigation of the action of the steam in the cylinder valve adjustments, and also the elimination of excessive friction and lubrication will represent and show up probably the most common sources of inefficient operation and restricted capacity of steam engines, the question of the steam supply should not be overlooked in the endeavor to secure more power or more economical results.

This involves a study of the steam pipe sizes, the steam pressure, the quality or dryness of the steam, the advantage of carrying superheat, and also the matter of impurities carried into the engine with the steam.

Many steam engines labor under the handicap of a restricted steam supply and deficient steam pressure without the operators being aware of the fact. Very often it will be found that a gain in capacity and economy can be secured by carrying a higher steam pressure, which in most cases can be done with very little extra cost. Take the relative economy of an engine operating at 75-lb. pressure and one operating with 100 lb. pressure in the steam chest, running with ¼ cutoff, and exhausting against 4 lb. back pressure. Assuming an engine clearance of 5 per cent, the ¼ cutoff will give a mean initial pressure of 0.625 lb. per pound absolute pressure. With 75 lb. gage, or 90 lb. absolute steam pressure, and 4 lb. gage back pressure, or 19 lb. absolute back pressure, the mean effective pressure would be 90×0.625—19, or 37.32 lb. With an initial pressure of 100 lb. gage or 115 lb. absolute, and the same back pressure, the mean effective pressure would be 115×0.625—19, or 52.96 lb. As the density of steam at 90 lb. absolute is 0.2044 lb. per cu. ft., and of steam at 115 lb. absolute is 0.2577 lb. per cu. ft., for the same cutoff and diagram factors, the relative weight of steam required per pound mean effective pressure would be as

$$\frac{0.2044}{37.32} \text{ is to } \frac{0.2577}{52.967} \text{ or as } 1.1256 \text{ to } 1, \text{ or a gain}$$

in capacity of about 12 per cent due to carrying a steam pressure at the engine of 100 lb. instead of 75 lb., which increase in pressure can be obtained without a corresponding increase in fuel cost.

A set of experiments made on locomotive engine cylinders several years ago showed the following results:

Lb. pressure.	Steam used per 1 hp.	Coal burned per 1 hp.
120	29.1	4.00
140	27.7	3.77
160	26.6	3.59
180	26.0	3.50

This shows a steady decrease in steam and fuel consumption as the steam pressure increased.

In this connection it should be borne in mind that the steam pressure generated at the boiler is not necessarily the pressure maintained at the engine cylinder because of friction losses in the piping, pressure drop, etc. Consequently where it is ascertained that a pressure of, say, 100 lb. at the engine throttle will give the most efficient results, steps should be taken to have the boiler pressure maintained at 110 or 115 lb., or whatever higher pressure is necessary to maintain the desired effective working pressure at the throttle.

This brings up the necessity and importance of a properly sized and designed piping system for conveying the steam from the boiler to the engine. The most important consideration is to be sure that the pipe is of the proper size. The size of the steam main can be readily checked by the rule.

$$W = 56.68 \frac{w\,(p_1 - p_2)\,d^5}{L}$$

W = weight of steam flow per minute.
w = weight of 1 cu. ft. of steam at initial pressure.
$p_1 - p_2$ = pressure drop.
d = diameter of pipe in inches.
L = length of pipe in feet.

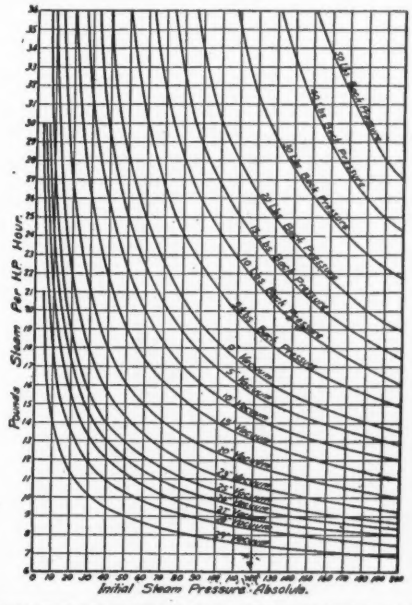


FIG. 1. RELATION BETWEEN INITIAL PRESSURE, BACK PRESSURE AND STEAM CONSUMPTION OF A PERFECT ENGINE. STEAM CONSUMPTION OF ACTUAL ENGINES IS AFFECTED IN ABOUT THE SAME PROPORTION

If the pipe is found to be too small, or the pressure drop excessive, because of many bends, turns and valve obstructions, the most convenient remedy is often to install a receiver at the engine throttle, to act as a storage reservoir to provide a full supply of steam from which the engine can draw. This receiver should be made large enough to hold from 2 to 4 times the cylinder volume of the engine. In estimating steam pipe sizes it is usually satisfactory to figure on a speed for saturated steam of 6000 ft. per min., though where ample receiver capacity is installed at the engine the speed can be safely increased to 7000 or 7500 ft.

Sharp turns and twists in the piping are also obviously undesirable because of the added resistance offered to the passage of the steam. If new piping is being done, or changes made, eliminate all unnecessary tees and elbows—running the pipe in as direct a line as pos-

sible—and in place of all elbows substitute long turn bends or wide sweep elbows.

Dips in steam pipes also tend to increase frictional resistance because unless thoroughly drained they become water pockets which restrict the pipe area and retard the steam flow. Pressure drop in the piping or reduced steam carrying capacity naturally follows if water of condensation is permitted to accumulate in any portion of the pipe, hence drains should be tapped into the steam line at all low points or pockets to remove the water. This matter of keeping water out of the steam lines is of extreme importance. It is also desirable to cover all the steam piping, not only because of the saving in heat, but because it assists in reducing the quantity of water of condensation present.

The exhaust pipe should be made amply large to carry off the steam at low pressure at a velocity of about 4500 to 5000 ft. per min. Tortuous exhaust piping passing through heaters and on to heating systems often imposes an undue back pressure on the engine, which can often be eliminated by passing a direct exhaust

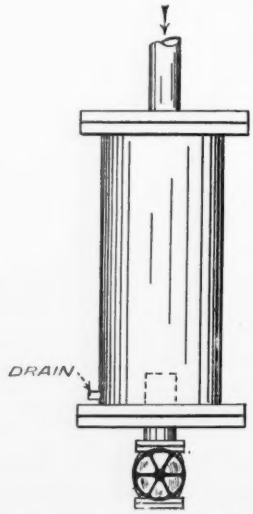


FIG. 2. ENLARGED SECTION OF STEAM PIPE NEAR ENGINE MAKES AN INEXPENSIVE RECEIVER

relief to atmosphere for use when the heating system is not in service. Back pressure valves incorrectly adjusted are also the cause of heavy back pressures which are not necessary. The back pressure against the engine should be adjusted in accordance with the requirements day by day instead of being set at one prescribed point and remaining there for months at a time. When the heating load is heavy it is economical to carry a high back pressure, but when the heating load is light, it is often possible to reduce the back pressure by 3 or 4 lb., thus enabling the engine to show better economy. In a 500-hp. plant running at 100 lb. pressure it was found that the steam consumption of the engine units when running with free exhaust was 30 lb. per horsepower-hour, whereas when running under 5 lb. back pressure the steam consumption was increased to 35 lb., involving an increase in operating cost of some 15 per cent. While it was necessary to carry the high back pressure at times in order to secure sufficient steam for heating, it was only necessary to reach this maximum point one or two days during the week, and during the remainder of the period a saving of 10 to 15 per cent could easily have been effected by arranging for reduced back pressure by adjusting the back pressure valve or by-passing some of the steam to atmosphere.

The work of the engine can also be materially assisted by insuring a supply of dry steam by installing a steam separator or dryer on the engine throttle. Entirely aside from the protection afforded against blowing out the cylinder head due to a slug of water coming over with the steam, the elimination of the water by means of a separator makes lubrication easier and less expensive because the oil is not so quickly washed away. Keeping the water out of the incoming steam also reduces cylinder condensation. Wear on the valve faces and seats, and on the cylinder walls, is also aggravated by the presence of water with the steam. The benefits of the separator are so widely recognized that it is standard practice today to equip all engines with this device. Frequently the separator can be conveniently combined with a receiver.

It has been estimated that the steam consumption of an engine increases about 1 per cent for every 2 to 3 per cent of water contained in the incoming steam, and it is very frequently the case that steam reaches the engine with this percentage of moisture, or more, and hence the investment in a separator to secure a reduction in steam consumption of 1 per cent or even more is most desirable, taking into account also the reduction in oil consumption, which often will run as high as 50 or 75 per cent. Where increased output is the desideratum, the installation of the separator should also be of material assistance. The quality of the steam reaching the engine can also be improved by installing a dry pipe in the boiler, covering all steam lines, by providing ample drains in the steam lines and headers, and by taking the steam connections off the top of steam mains and headers.

Superheating is also an aid in securing dry steam for the engine. Water vapor arising from any cause cannot exist in superheated steam (steam that has an extra supply of heat), so long as it remains superheated. because the water immediately robs the steam of some of its excess heat and is re-evaporated into steam. When using saturated steam, any slight cooling effect in the steam pipe or in the steam engine cylinder due to condensation precipitates more moisture out of the incoming steam, representing a heavy loss, as the condensate and the heat represented in it is worthless in producing useful work in the engine. This loss, usually known as cylinder condensation, runs from 10 to 30 per cent of the total steam used in the engine, and ordinarily averages from 12 to 18 per cent. Where superheated steam is used no cylinder condensation takes place, or to a very limited extent, until the temperature of the steam is reduced to the saturation point because the superheat as it is given up heats the engine walls without any condensation taking place to accomplish it. The exact amount of superheat necessary to prevent cylinder condensation varies with circumstances, but it is probable that from 5 to 10 deg. of superheat should be used for each 1 per cent of moisture present in the steam when no superheater is employed. In engine practiee, it is advisable to limit the superheat carried to around 100 deg. be-

cause higher temperature would cause distortion of the valves, and would also probably cause trouble in securing adequate lubrication.

Superheat is especially desirable for use in connection with compound engines where it is desired to reduce to a minimum the cylinder condensation in the initial cylinders of the engine. Some published tests on a compound engine showed a steam consumption of 13.4 lb. of steam per horsepower-hour, using saturated steam, whereas superheated steam at the same pressure cut down the steam consumption to 10.2 lb., a saving which yielded a return of 30 per cent on the investment in the superheater attachment on the boilers, revised piping, and a new high-pressure engine cylinder.

The presence of grit carried into the engine with the steam may also represent a source of trouble which it is advisable to investigate. Frequently where the feed water is of poor quality or is treated with boiler compounds or chemicals, foaming and priming take place and solid impurities and mud are carried out of the boiler with the entrained water, and find their way with the steam and water into the engine. There the gritty substances and mud will naturally exert a cutting and wearing action on the valves and cylinder walls, increase the friction loss and make necessary more thorough lubrication. As indicating the extent to which grit and mud entrained in the steam can affect lubricating costs, the experience of one engineer with a large Corliss engine showed that, while over 5 gal. of cylinder oil per day were required to keep the valves quiet, after the entrained moisture carrying the mud and grit was eliminated by means of more careful boiler operation, and the installation of a steam separator, the quantity of oil required was cut down to ¾ gal. Entrained grit will largely be removed with the water by a steam separator, though in some cases it will be necessary to readjust the boiler operation or the water treatment, so that the foaming or priming tendency is eliminated.

A Flexible Condenser Installation

TWIN SHELL SURFACE CONDENSER SOLVES PROBLEM OF LOW HEADROOM UNDER CROSS-COMPOUND TURBINE UNIT. BY A. H. GANSHIRD*

THE Duquesne Light Co. of Pittsburgh, Pa., has recently placed a twin shell, 56,000-sq. ft. surface condenser into operation and some rather unusual features are embodied in the design of the complete condensing unit. Special provisions have been made to assure continuity of service and flexibility of operation. The general layout of the condenser auxiliaries is representative of good condenser practise, and shows the present tendency toward the installation of spare pumping units with large surface condensers.

The 40,000-kw. Westinghouse cross-compound turbine unit which this condenser serves, is installed in an old station and the headroom in the basement is very low for a unit of this size. If a single shell condenser had been chosen, it would have been necessary to lower the basement floor level in order to obtain the necessary headroom which was only sufficient to accommodate a condenser of about half the required capacity. Since the turbine is of the double flow design, it was comparatively simple to adapt two 28,000-sq. ft. shells to the turbine and this type of condenser was chosen as being the most suitable.

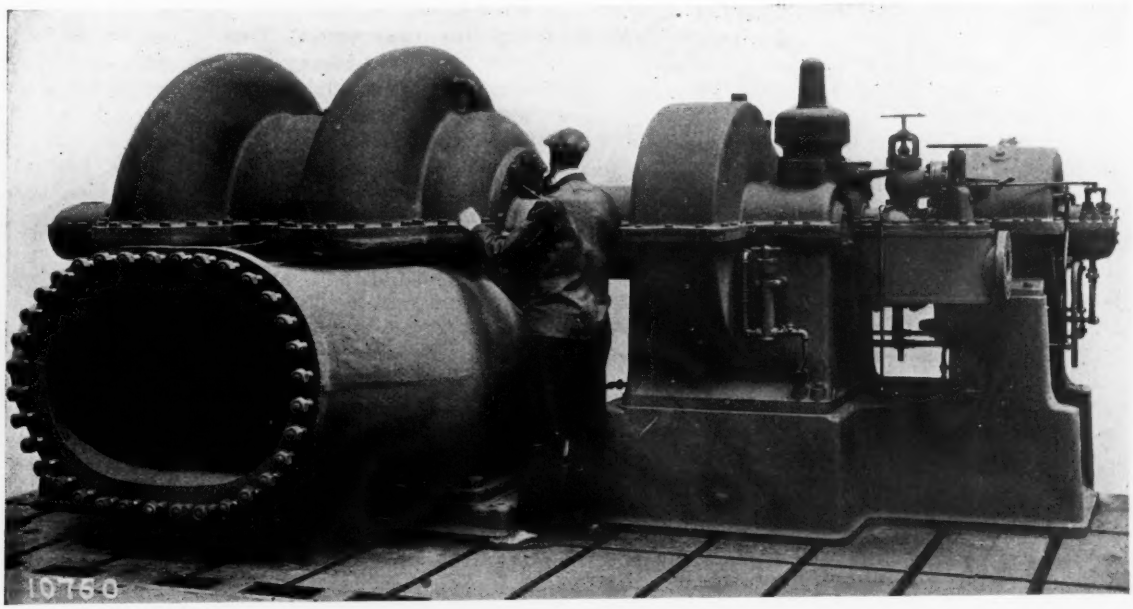


FIG. 1. GEARED TURBINE DRIVEN CIRCULATING PUMP

Each shell is of the conventional two-pass design with the additional feature of vertically divided water chambers and the necessary extra circulating water and

*Of the Westinghouse Electric Mfg. Co.

air pump connections. A vertical partition is placed in each water chamber and the circulating water piping so arranged that either half of either shell may be independently operated. Extra air baffles are provided so that the air is removed from the side of the condenser which is in operation, or from either side when water is circulating through the tubes. The water chamber covers are divided on the vertical center line and either half may be removed for cleaning or inspecting the tubes while the other half of the condenser is in operation.

The shells are set at right angles to the turbine axis and are connected to the turbine exhaust openings by short connecting pieces. No expansion joints are used since the condenser shells are supported on heavy car springs which allow for any downward expansion.

With a double flow turbine it is necessary to maintain the same vacuum at each turbine exhaust and to accomplish this, the steam spaces in the two shells are connected by an equalizing pipe. This also permits the two condensers to divide the load equally when part of one condenser is out of service. In case of light loads and cold water one condenser could be taken out of service temporarily.

Circulating water for this condenser is taken from the Ohio River and since the water is of rather poor

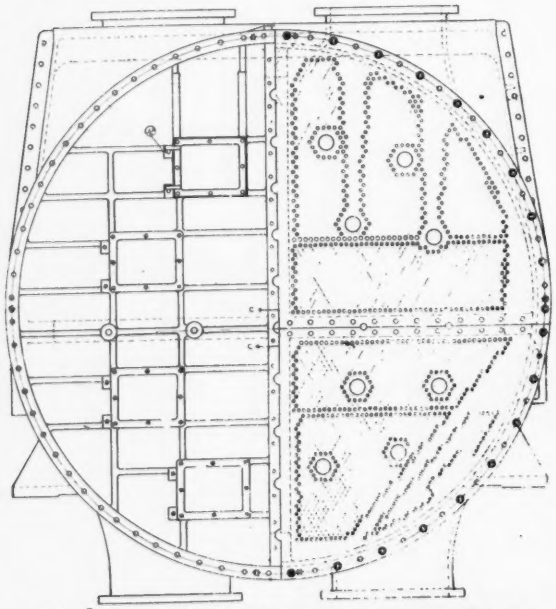


FIG. 2. VIEW OF CONDENSER SHELL ASSEMBLED

quality, great care has been taken to prevent fouling of the condenser tubes. Revolving screens are installed at the intake end of the tunnel and each circulating pump discharges through a six-basket strainer. With these features, and the divided water chambers on the condensers, it is not expected that the unit will need to be taken out of service for cleaning the condensers.

Three circulating pumps are installed to serve the two condensers, but any two pumps are of sufficient capacity to handle the water required by the condenser. The discharge piping is so arranged that any one of the pumps may supply water to either half of either condenser and with this arrangement the greatest flexibility and reliability is obtained.

Each condenser shell is served by a Westinghouse LeBlanc air pump and a condensate pump of sufficient capacity to handle all the condensate from the unit is coupled to each air pump and driven by the same prime mover. This provides a reserve condensate pumping unit and if the installation is reasonably free from air leaks, one air pump should remove the air from the unit with only a slight decrease in vacuum. By combining the air and condensate pumps the pumping units are reduced to a minimum and the general layout much simplified.

Since the air must be removed from the side of the condenser in service when water is circulated through only one-half of the tubes, the air suction pipes are connected to openings on each side of the shells. The piping is interconnected so either pump may be used with either shell. When both pumps are in operation their suction openings are connected in order that they may equally divide their load and also to assist the condensers in maintaining the same vacuum.

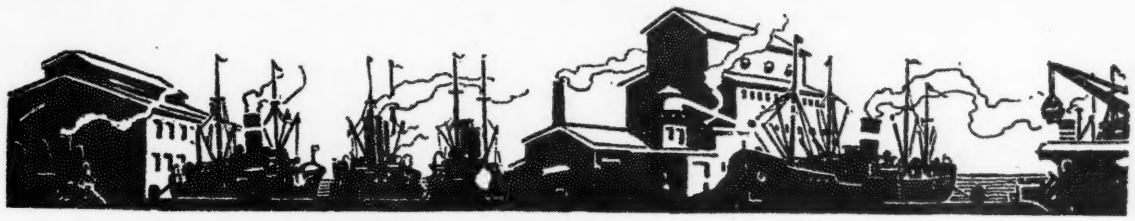
The LeBlanc air pump is not capable of discharging its hurling water against the head existing in times of high water if it is discharged back to the river, so it was found best to install a tank for the injection water. One tank serves both air pumps and the water is used over and over again.

Since any hurling water vacuum pump condenses a small amount of vapor, there is a slight rise in temperature of the water, and if the water is circulated through the pump several times, it becomes so hot as to lower the efficiency of the pump, since its air handling capacity is dependent on the hurling water temperature. For this reason it is necessary to admit a small amount of cool water to an air pump tank. In this installation, the overflow from the tank is returned to the river by gravity except in case of high water, when it is necessary to use a small overflow pump to deliver the water against the existing head.

The circulating pumps are driven by geared turbines and the air, condensate and overflow pumps are driven by direct connected turbines. All of the turbines operate noncondensing and the exhaust steam is used for feed water heating.

Continuity of service is demanded of central stations and spare generating units must be provided or some provision made for keeping the minimum number of units in continuous operation. The most frequent causes of trouble with the condenser are the failure of auxiliary units and cleaning the tubes. The installation of spare pumping units as in this plant practically eliminates the first cause of a shutdown and the divided water chamber condenser reduces the time lost in cleaning the condenser to a minimum.

With the divided water chamber condenser, half of the condenser can be kept in continuous operation while cleaning the other half of the tubes, and if the total surface is divided between two shells, three-fourths of the condenser unit may always be in service. This would produce sufficient vacuum to operate the main unit condensing with only a slight decrease in capacity and economy.



Blocking New Wars

BUSINESS PROTECTS DEMOCRACY, POWER OF THE PEOPLE'S THOUGHT AFTER THE WAR. BY HERBERT S. HOUSTON, MEMBER OF THE CHAMBER OF COMMERCE OF U. S. A., ON ECONOMIC RESULTS OF THE WAR*

IN ALL countries the development of commerce has been accompanied by a gradual but inevitable development of democracy. So general is this that the deduction is sound that between the two there is a relation of effect and cause. The reason for this is not obscure, for it inheres in the very nature of both commerce and democracy. They both stand for cooperation in human relationships. As commerce grew it became a constantly increasing source of revenue to governments and secured a constantly increasing number of rights and privileges. Many of these came after long struggle, but they always bore witness to the growing power of commerce, which won them. In time, especially in English-speaking countries, commerce became included in the encompassing word business, which stood for the whole range and field of commercial enterprice. Today business is practically the organized life of the world.

One of the most significant consequences of the commercial organization of the modern world has been the stimulus it has given to the democratic idea. When men meet on a plane of equality in business and develop both the philosophy and the practice of democracy, it becomes inevitable that their relations with their governments should work surely toward democratic ideals and principles. And that fact explains much of the democratic progress that has been going on all over the world. Even in autocratic nations where government has continued to be largely in control of the hereditary nobility there has grown up a great commercial class, grounded in the democratic idea of individual worth, opportunity and initiative and from this class the government service in every country has been constantly recruited. As a result there has been a steady democratic infusion from business that has profoundly affected political thought everywhere, because men who have climbed up from the ranks seldom lose "the common touch," however influential they may become in government affairs, and with whatever titles they may be invested. It is these men who are a material part of the leaven of constructive liberalism in every country against irresponsible autocracy on one hand and irresponsible democracy, representing the rule of the mob, on the other. In the international reconstruction toward which the world is fast moving they may be expected to bear an important part. And it is a cheering fact to recall at such a time that their training and their views are not only largely democratic but, to a considerable degree, international. In business within, they have been schooled in the democratic practice of equality; in business without, in the field of world trade, they have learned something of international forces and relationships.

During the war a striking illustration of the stabilizing influence in international affairs of business men has been offered in the work of the International Sugar Committee. This committee was composed of three members from the United States, Earl D. Babst, president of the American Sugar Refining Co.; George M. Ralph, head of the Sugar Division of the Food Administration, and William A. Jamison of Arbuckle Brothers, and there were two members from the Allied governments, Sir Joseph White-Todd and J. Ramsay Drake, both of England. These five men in the fall and winter of 1917-18, by co-operative buying and control of distribution, succeeded in overcoming an almost panic condition, due to threatened famine, stabilized conditions that bordered on demoralization and established an equitable balance between the rights of producers and consumers in all of the Allied countries. This result in a single industry is indicative of what business men may accomplish in the new international conditions that will come with a league of nations.

Another illustration that is even more important is that of the pooling of all shipping interests among the Entente Allies. An International Shipping Board was formed with P. A. S. Franklin, president of the International Mercantile Marine, as chairman, and H. H. Raymond, the shipping controller of the Food Administration, as the American members, and with Sir Connop Guthrie as the English member. And this Board took under control the unification and direction of all the shipping services of the Allies. So conservative a newspaper as the New York Times, in commenting on this radical departure, said: "This war is different from other wars in that its results will be economic rather than territorial or dynastic. There will be territorial readjustments with peace. There have been dynastic and political revolutions, and there will be more. It was not intended to minimize them when it was suggested that they were rivaled by the passage of the world from a past of economic nationalism into a future of economic internationalism."

The truth is the league of nations that has been fighting the war for democracy has been learning how to apply economic internationalism as a force to maintain peace when a greater league of nations is formed.

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The People Speak

Democracy in its advance has kept step with the progress of knowledge. Not until the war was recognized as a crucial struggle for the preservation of individual liberty did it set up the fundamental issue that united the democratic nations of the Old and New Worlds. The full support of free and independent men came only through a realization and understanding of the cause for which they were called to sacrifice and die. The United States did not enter the war until its people had given unmistakable proof of their conviction and will.

How was this proof presented? Through the great democratic organ of public opinion, the press. The history of those anxious days of our neutrality shows the touchstone was applied to the sovereign force of public opinion. The successive public addresses of President Wilson prior to April 6, 1917, trace the emergence of the United States from its traditional policy of national isolation. Editorial comment in more than 2000 daily newspapers assured the President that the people were with him at each step toward the final call to arms. How carefully the head of the nation studied the popular effect of these messages was demonstrated by the fact that summaries of editorial opinion embracing extracts from several hundred leading newspapers in every part of the country were laid before him within twenty-four hours after the publication of an address or message. These summaries, made by the Associated Press, not only kept the President informed of the state of the public mind but mobilized opinion throughout the nation.

Having agreed to fight, after free and open discussion through the press, the people of the United States utilized the same agency in mobilizing for war. The campaigns to conserve our resources and to finance the war owed their success principally to the support of the newspapers. Printers' ink accomplished for America what was possible in Germany and Austria only through imperial decree and the fear of armed authority.

Through their newspapers the people of the United States became familiar with the principle that the only kind of peace worth fighting for is a permanent peace, based upon international covenants. The ideal of international reconstruction was launched by the League to Enforce Peace.

A careful survey of editorial opinion at the time this book is written indicates that, while there are differences of opinion as to method, the general plan of a league of nations is favored by the newspapers in overwhelming majority.

The attitude of the press is significant because upon this great clearing house of public opinion will rest much of the responsibility for the success of the plan once it is adopted. All the nations are gaining greater respect for the views of their neighbors. The telegraph, the submarine cable and the telephone rank with the railroad, the steamship, the automobile and the airplane as agencies drawing mankind into one great family. If a citizen with a quarrel on his hands knew that his neighbors sided with his opponent, he might think twice before venturing to gain his ends by force. In the same way a nation, however aggressive and ruthless, would hesitate to attack another if it believed the other nations of the world would not support its quarrel.

Here is where the machinery of an international court and forced arbitration would serve to block an outbreak of hostilities until the questions at issue could be laid before an international jury. Since the proceedings of such a tribunal would be public, long before the court had handed down its decision the issue would have gained a popular verdict. The press of the world would act as unofficial advocates and the case would be tried first at the bar of public opinion.

If the quarrel reached the stage where the united nations decided to use the trade boycott against an offending member of the league, either with or without military force, such a boycott could not be successful unless it were backed by the people.

In fact, public sentiment alone, without official action, might be strong enough to exert effective economic pressure if mobilized and directed by the united efforts of the press. This is the idea back of the 1918 referendum of the United States Chamber of Commerce. A boycott such as this plan proposes would be purely popular and without government sanction.

Under the domination of an autocratic government a national press can become a powerful instrument to advance the interests of selfish despotism. But the free press of America, uncensored and responsible only to the people upon whom it depends for support, has proved itself one of the most effective weapons in the arsenal of democracy.

The New Day After the War

The great war is in its fourth devastating year as this book is published. What will follow it in the way of world reorganization no one can clearly foresee. But that great changes are impending is no longer looked upon as prophecy, for their necessity and inevitability are everywhere understood and conceded.

There are three forms which these changes could conceivably take.

1. Increased imperialism in the world—by that is meant increased militarism and increased territorial empire under the control or sovereignty of a single nation.

This change seems to be impossible, for to bring it about would require complete German victory. Unless that is achieved imperialism cannot have a place in the world any larger after the war than it had before the war, for the allied nations have made their fight for the underlying principles of democracy. Their governments have stated in the most definite form that they were agreed in favor of equality among nations, small and great, in favor of each country determining its own government and in favor of a policy of no annexations.

If these principles should suffer defeat in this war it can be but a temporary defeat, for these principles are eternal and must ultimately prevail. And they must prevail in Germany and Austria and Turkey, quite as much as in France, England, America and throughout the world. To hold to any other view is to deny progress and to shut out the light of history.

A change that would represent the farthest possible extreme from imperialism would be:

2. Radicalism in the extreme form it has taken in Russia under the rule of the Bolsheviki or in the form represented by the British Labor Party.

This is a result that is not impossible in the sense that the imperialistic result appears to be, but it is highly improbable. Representative democracy, before the war came, had gained the day in England, in France, Italy and America, and it will not surrender all it has won, in a thousand years of steady progress, to the red flag of socialistic revolution. But this is not said in denial of the profound effect which the Russian revolution is having and will continue to have on the democracy of every country in the world. The full measure of that effect is not apparent—will not be for generations—but among events that have been influenced, to some degree at least, are the great strikes in Germany and Austria in favor of a democratic peace and the formation of an independent Labor Party in England, with so strong a demand for a statement of war aims that Lloyd George was compelled to heed it. About the time Lloyd George spoke, President Wilson gave to the world a statement of America's war aims and these were at once taken up by English labor and claimed as their own. And as these declarations were being made, Trotzky, the Russian Foreign Minister in the Bolsheviki government, published a book, "The Bolsheviki and World Peace." In it he gave this formula for peace—"The peace of the peoples themselves and not the reconciliation of the diplomats. No contributions. The right of every nation to self-determination. The United States of Europe—without monarchies, without standing armies, without ruling feudal castes, without secret diplomacy."

This was written, evidently, a short time before Lenine and Trotzky came to power and, in substance, it was the formula presented by the Russian delegates at the council table at Brest-Litovsk, although they failed utterly in securing its adoption. Of course the Allies have the deep conviction that Russia in making a separate peace with Germany was guilty of an act of the basest treachery. It is clear that it released great armies for another drive toward Paris, and was followed by a new drive for conquests in Russia. But it released, also, great armies of radical ideas that have made an insidious and powerful attack on the morale of the German people. Which groups of armies, those operating outside Germany or those operating inside, would do the greater destruction was not determined when this was written. But they were engaged in accomplishing results that were violently contradictory.

And in Russia there has been some reaction from the radical influences that have been in full swing. To what degree the Bolsheviki have been affected by more moderate democratic influences is not clear, but it can be safely believed that they have been much affected and that, ultimately, either their views will be influenced from without, in as large measure as they have themselves influenced the views of other democracies, or the Bolsheviki will be supplanted by those representing more conservative ideas. This is but stating the fact that as a rule human reactions, in time, establish an equilibrium. No gift of prophecy, therefore, is needed to foresee that the world, after the war, will not go all the way to the international socialism that is accepted and proclaimed by the Bolsheviki.

The able report on reconstruction by the sub-committee of the British Labor Party presents the farthest swing which the pendulum of radical liberalism can be expected to make. As the proposals in this report will unquestionably be advocated for adoption by an important section of the British Parliament—it is not impossible that the next general election in England will show that that section represents a majority—they must claim at once the serious attention of all thinking people. Count Okuma is credited, in this report, with having expressed the view, from his vantage point of perspective in Japan, that the present conflict would result in the death of European civilization. "We of the Labor Party can so far agree in this estimate," says the report, "as to recognize in the present world catastrophe, if not the death, in Europe, of civilization itself, at any rate the culmination and collapse of a distinctive industrial civilization, which the workers will not seek to reconstruct. At such times of crisis it is easier to slip into ruin than to progress into higher forms of organization. That is the problem as it presents itself to the Labor Party.

"What this war is consuming is not merely the security, the homes, the livelihood and the lives of millions of innocent families, and an enormous proportion of all the accumulated wealth of the world, but also the very basis of the peculiar social order in which it has arisen. The individualist system of capitalist production, based on the private ownership and competitive administration of land and capital, with its reckless 'profiteering' and wage-slavery, we shall do our utmost to see that it is buried with the millions whom it has done to death. If we in Britain are to escape from the decay of civilization itself, which the Japanese statesman foresees, we must ensure that what is presently to be built up is a new social order, based not on fighting but on fraternity—not on the competitive struggle for the means of bare life, but on a deliberately planned co-operation in production and distribution for the benefit of all who participate by hand or by brain—not on the utmost possible inequality of riches, but on a systematic approach towards a healthy equality of material circumstances for every person born into the world—not on an enforced dominion over subject nations, subject races, subject colonies, subject classes, or a subject sex, but, in industry as well as in government, on that equal freedom, that general consciousness of consent, and that widest possible participation in power, both economic and political, which is characteristic of democracy. We do not, of course, pretend that it is possible even after the drastic clearing away that is now going on, to build society anew in a year or two of feverish reconstruction. What the Labor Party intends to satisfy itself about is that each brick that it helps to lay shall go to erect the structure that it intends, and no other.

"The four pillars of the house that we propose to erect, resting upon the common foundation of the democratic control of society in all its activities, may be termed:

"(a) The Universal Enforcement of the National Minimum Wage.

"(b) The Democratic Control of Industry.

"(c) The Revolution in National Finance.

"(d) The Surplus Wealth for the Common Good."

After presenting arguments in favor of these pro-

posals the report gives this unqualified endorsement to the league of nations:

"We stand for the immediate establishment, actually as a part of the treaty of peace with which the present war will end, of a universal league or society of nations, a supernational authority, with an international high court to try all justiciable issues between nations; an international legislature to enact such common laws as can be mutually agreed upon, and an international council of mediation to endeavor to settle without ultimate conflict even those disputes which are not justiciable. We would have all the nations of the world most solemnly undertake and promise to make common cause against any one of them that broke away from this fundamental agreement. The world has suffered too much from war for the Labor Party to have any other policy than that of lasting peace."

This leaves the third change that may follow the war to be examined. And that stands midway between the two extremes of imperialism and radicalism. It can be stated, broadly, in this fashion:

3. Representative democracy existing in nations and serving as a bond of union in a league of nations.

This is an approximately accurate description of the political principles of the Entente Allies in the war. With the exception of Japan, whose government has been steadily becoming more democratic since 1868, each of them has a government directly responsive and responsible to the people. And this fact has been a controlling factor in bringing them together and in holding them together in a league. It has made sharp and clear-cut the battle line between democracy and autocracy and thus has determined the decisive purpose of the war. Now democracy is not socialism. It stands for the individual, for his initiative, for his rights, for his freedom. Democracy is the creed of the Gospel, for it interprets the underlying and unescapable obligation in personal responsibility. Germany forgot her Luther or she could never have forged such a thunderbolt as Prussian militarism. But the printing press which her Gutenberg set up in Mainz has served as a mighty instrument of democracy. It made possible the spread of knowledge, which has been both the cause and the hope of modern civilization. The printing press has been the screw of Archimedes that everywhere has been lifting men into a consciousness of their manhood. Serfdom has had to go, slavery has had to go, feudalism has had to go—and democracy, based on the rights of man, had to come. And in all the centuries it has been coming, slowly, oh very slowly at times, but coming, surely coming. It has been coming in Germany through the growing rise of the people's power; in England, through the revolution in which the inherited power of the lords has been shattered and the supreme power of the people recognized; in all modern Europe it has been coming; in Turkey, in Persia, in China it has been coming; in America it has been coming.

Vested power will entrench itself in many strong positions in the generations to come, as it has in the past, but it must lose them because its fight is against men and women who are being raised by the democratic power of the printing press into reliant, strong, conscious individualism. When the printing press gave knowledge to the world it gave the power to the world that was to make it democratic. Learning was no longer the privilege of the few but the possession of the many. The Bible was no longer chained to cathedral pulpits but found its way into the humblest home. Government was no longer vested in kings, and though thrones might remain, they have become merely symbols of a power transferred in increasing measure to the people. The world had to be democratized.

The great war itself has been an agency of democracy. It is unbelievable that the millions who have fought it, on the firing lines and behind them, can be brought under subjection to autocracy. It may be believable, but it doesn't appear to be probable, that they will carry democracy to the point of extreme radicalism. Instead, it is more reasonable to look forward to a world after the war in which democracy will be truly representative, controlling governments within nations and serving as a bond of understanding and union between nations in a League to Enforce a just and durable Peace.

What Is Graphite?

THIS question was asked one day in a group of engineers, and as a result of the discussion the following facts were brought out:

Carbon exists in three forms; the first as seen in coke, charcoal, lampblack and like substances having a specific gravity about 2.15, no crystalline structure and no unctuous or lubricating qualities. The second is the diamond, transparent, crystalline, very hard and with specific gravity of 3.45.

The third, graphite or graphitic carbon, also known as plumbago or black lead, has a gravity of 2.25, and is distinguished by smoothness or softness to the touch, known as unctuousness. Graphite may be artificial or natural, and may be crystalline or amorphous, the artificial being always of the latter form.

A Hymn of Loyalty

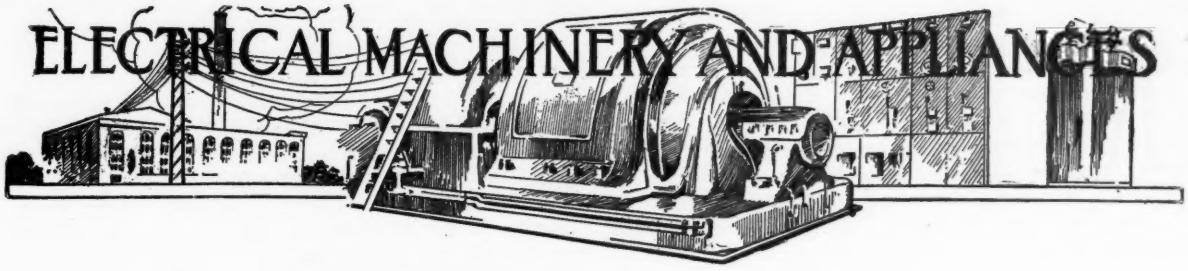
(Air: "America.")

By Joshua O'Leary

Loved Country, great and free,
Beacon of Liberty,
Ever shine bright.
Cheered by thy glorious rays
Freeman shall hymn thy praise
And bless through all their days
Thy saving light.

Guardian of freedom's cause,
Whose just and equal laws
Shield us from birth.
Make all the world to be
Safe for Democracy,
That Peace and Liberty
May reign on earth.

God save our President,
Leader the people sent
To guard our land.
Standing for nations free,
Voicing humanity.
Lord God, we pray to Thee
Guide Thou his hand.

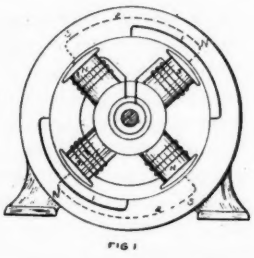


Synchronous Motor Action

PRINCIPLES OF OPERATION; CONDITIONS AFFECTING TORQUE; METHODS OF STARTING; BOOSTING POWER FACTOR. BY GORDON FOX

IT IS a familiar fact that the synchronous motor is nearly identical in construction to the revolving field alternator. It is not so well known, however, how the synchronous motor produces torque nor why its performance differs in many respects from that of the more familiar induction motor.

The rotor of a synchronous motor is made up of a number of radial pole pieces inserted in a spider. These pole pieces are magnetized by coils carrying direct current introduced through slip rings. The stator has a smooth bore with distributed windings inserted in slots, just as in the alternator or induction motor. The stator winding is connected to the multiphase alternating current circuit. It is general knowledge that a revolving magnetic field is set up in the stator winding of an induction motor by the action of multiphase currents in its distributed stator windings. The conditions in the case of the synchronous motor stator are similar to those existing with the induction motor. A revolving field is set up around the bore of the stator of a synchronous motor in exactly the same way that it is produced in an induction motor.



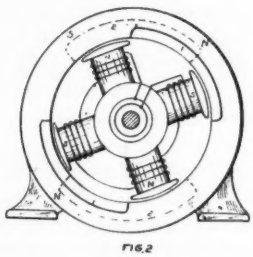
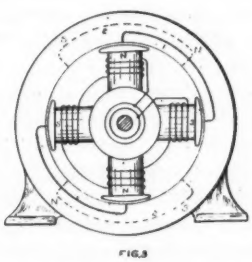


FIG. 1. POSITION WHERE NO TORQUE IS DEVELOPED
FIG. 2. POSITION FOR STABLE OPERATION

When the rotor is at rest, we may consider a given field pole as being directly under a given conductor of the stator. The polarity of the field coil is fixed. The current in the stator conductor is alternating. The current in the stator conductor reacts upon the field magnetism to produce a torque, but this torque changes in direction with every alternation of the current. The resultant torque is therefore zero. If one field pole could be under the conductor while its current flows in one direction and the next field pole, of opposite polarity, could be under the same conductor while its current flows in the opposite direction, the torques resulting would be unidirectional and would aid rotation. For this to occur, the rotor must revolve so that the field poles advance 180 electrical degrees during a half cycle of current values. The field poles then advance 360 electrical degrees during a full cycle. In an induction motor the rotating field advances 360 electrical degrees during a cycle of current values. The field of a synchronous motor revolves in exactly the same manner as that of an induction motor. The rotor of a synchronous motor must therefore revolve in exact synchronism with the revolving field of the stator if unidirectional torque is to be obtained. At any other speed, the torque at one instant will be forward, the next instant reversed and the motor will stall. The synchronous motor derives its name from the fact that the rotor must revolve at synchronous speed, regardless of its load, or else lose its torque.



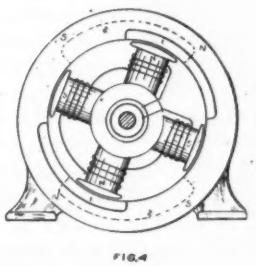


FIG. 3. POSITION OF MAXIMUM TORQUE
FIG. 4. POSITION FOR UNSTABLE OPERATION

The torque afforded by any motor must automatically adapt itself to correspond with changes in the external load. In an induction motor, this adjustment of torque is brought about through the slip of the rotor. In a synchronous motor the rotor must revolve at synchronous speed or not at all. The action which enables the torque developed in a synchronous motor to adapt itself to the load may be explained by the aid of Figs. 1, 2, 3, and 4. These figures show diagrammatically the field poles and a portion of the stator winding of a two-phase synchronous motor. They represent instantaneous positions of the poles of the stator's revolving field. The poles of the revolving field have this position only at the instant when the current in phase 1 is a maximum. At this instant the current in phase 2 is zero. Two coils of phase 1 are shown in full and two coils of phase 2 are shown dotted.

Consider the field poles to be in the position of Fig. 1. At the instant represented in all the figures, the current in phase 1 is a maximum and the current in phase 2 is zero. Since the poles are located under conductors of phase 2 having zero current, no torque is developed.

Consider the rotor poles to be in the position shown in Fig. 3. The poles are located under the conductors whose current value is at its maximum. Maximum torque is here secured through reaction between stator current and rotor field magnetism.

Consider the rotor poles to be in the position shown in Fig. 2. They are then located partially under conductors of phase 1 and partially under conductors of phase 2. These intermediate conductors are not shown in the figure. The windings of each phase are actually distributed around the bore instead of being located in single slots as indicated in the figure. For the position shown in Fig. 2, the torque is less than that of Fig. 3, since less conductors of phase 1 are under the pole and effective in exerting torque.

Consider the rotor poles to be in the position shown in Fig. 4. Here also the poles are in an intermediate position only partially under the current carrying conductors of phase 1. Here also the torque afforded is less than the maximum value shown in Fig. 3.

In general, the torque of a synchronous motor is adjusted to the external load according to the relative position taken by the field poles with respect to the stator conductors whose current is passing through its maximum value.

If the motor were running light with the approximate relation of Fig. 1 and a load were added, the rotor would lag slightly, not in speed but in angular position, so that some intermediate position, such as that of Fig. 2, would be taken. Further increase in load would cause further lag until the position of Fig. 3 is reached. The motor now develops its maximum torque. If the load is still further increased, the rotor will be further retarded to some such position as that of Fig. 4. The position of Fig. 3 is that affording maximum torque. Conditions of operation in the zone of Fig. 4 are such that, as increase of load causes retardation of the rotor, less stator conductors of phase 1 lie under the pole and the torque producing ability is diminished, so that the motor stalls.

If the motor is operating in some position such as that of Fig. 2, an increase in load causes a retardation of the armature, with attendant gain in driving power up to the maximum torque of the motor. Operation in this zone is therefore stable. If the motor is operating in the position shown in Fig. 4 an increase of load retards the rotor, with attendant decrease in driving power. Operation in this zone is therefore unstable. In ordinary service, a synchronous motor operates only in the general zone represented by Figs. 1, 2, and 3.

Consider the relations existing as in Fig. 3. Let the rotor field magnetism be strengthened by increasing the direct current excitation. Increase in magnetism increases the torque and the rotor tends to advance until it reaches some such position as in Fig. 2, where torque production is less favorable. If, instead of strengthening the magnetism, we had weakened it, the rotor, instead of advancing, would have been retarded into the unstable zone and the motor would stall. Strengthening the rotor field evidently increases the torque for any given position and causes the rotor to advance. As the rotor advances, it passes into more stable operation. Also, the maximum torque is increased. Operation with strong rotor field is thus seen to be more stable than operation with weak field. The breakdown capacity is also greater with a strong rotor field.

It was brought out in connection with the study of induction motor action, that a wattless current is required to magnetize the stator and to provide the stator's revolving field. If a synchronous motor is operating with a strong field, in some such position as that of Fig. 2, the rotor field favors the stator field. The stator tends to maintain a field of fixed value, just as the primary magnetism of an induction motor is held constant. Since the rotor magnetism favors the stator field, if the rotor's magnetizing influence is sufficiently strong the stator need not set up its own field. There is then no wattless current taken from the mains. If the rotor's magnetizing influence is overstrong, a wattless counteracting or demagnetizing current flows through the stator conductors. A demagnetizing current is a leading current. Hence, an overstrong rotor field will cause a leading wattless current to be drawn from the line. Conversely, if the rotor's magnetizing influence does not set up a field equal to that demanded by the stator, a portion of the magnetizing current must be furnished by the stator. Magnetizing current is wattless and is a lagging current. Thus, operation with a weak field will cause a lagging wattless current to be drawn from the line. It is evidently possible to control the power factor of a synchronous motor so that it may be unity or so that either leading or lagging wattless current is drawn from the mains. This is one of the most important features of synchronous motor action.

The synchronous motor produces torque only when it is running at synchronous speed. No torque is produced by synchronous motor action when the motor is at rest. It follows that some means must be employed to accelerate a motor of this type to synchronous speed. If the motor is used as one unit of a motor generator set, it is sometimes possible to utilize the other unit of the set for starting. This can be done in the case of exciter motor generator sets, for instance.

A synchronous motor is sometimes started by use of a small auxiliary induction motor. This auxiliary starting motor has less poles than the synchronous motor so that its synchronous speed is slightly higher than that of the larger unit. The set is started by means of the induction motor with the synchronous motor disconnected from the line. The fields of the synchronous motor are next excited and this unit builds up voltage as an alternator. It is then synchronized with the line, the procedure being identical with that of an alternator. At the instant of synchronism, the motor primary is connected to the line. The auxiliary induction motor is then shut down and the synchronous motor is ready for its load. It is evident that the load which may be started by this method is limited by the size and torque of the auxiliary induction motor. Sets of this type are used only where the starting service is comparatively light or where the load may be disconnected at starting.

It is possible to start a synchronous motor through induction motor action inherent in the machine itself. The stator of a synchronous motor is nearly identical

with that of the induction motor. Application of polyphase alternating current to the stator winding causes a revolving field to be set up. Eddy currents are produced in the pole pieces by the revolving field. These eddy currents act similarly to the secondary currents of an induction motor, producing a small torque which may be sufficient to start the motor without load. Much more effective induction motor action may be secured if a squirrel cage winding, similar to that of an ordinary induction motor, is provided by embedding copper bars in the field pole tips and short-circuiting them with end rings. Motors provided with a squirrel cage winding on the field poles will develop 15 to 25 per cent of their full load torque with approximately full load current when about half voltage is applied to the primary windings at starting.

A self-starting synchronous motor depends, for starting and acceleration, upon induction motor action. An induction motor never attains synchronous speed. A synchronous motor cannot attain synchronous speed through induction motor action. If the motor is brought up to a speed sufficiently near synchronous value, it will "pull in" to synchronism through synchronous motor action. During this period the rotor fields are excited by wattless current in the primary windings. A very considerable magnetizing current is required because of the wider air gap and poorer magnetic circuit of the synchronous motor. Consequently, during this "pull in" period, a heavy wattless current is taken, restricting the intake of useful current and thus restricting the torque.

There are two points of limited torque during the acceleration of a self-starting synchronous motor. One of these is at standstill, the other at "pull in" speed just below synchronism. The torque produced per ampere input at standstill may be made quite high if the squirrel cage winding is of comparatively high resistance. Brass or german silver are sometimes used instead of copper for this winding, in order to secure the high resistance. The gain in standstill torque may be at the expense of "pull in" ability, however. The slip of an induction motor is greater the higher the secondary resistance. A synchronous motor equipped with a high resistance squirrel cage winding will attain a lower speed through induction motor action than would be reached if the squirrel cage winding were of low resistance. It is evident, therefore, that gain in torque at standstill is made at the expense of "pull in" ability. The type of squirrel cage winding to be used must be suited to the load to be accelerated. A fan or centrifugal pump takes but little torque at standstill, but may attain considerable load near synchronous speed. Here a low resistance squirrel cage will be best suited. An air compressor, unloaded, requires considerable torque to overcome static friction but accelerates easily. Here a higher resistance rotor may be better suited.

In an endeavor to secure both high starting torque and low slip, some synchronous motors are designed with a wound rotor similar to that of an induction motor. The winding on the rotor is star connected and terminates at three slip rings. During the starting operation the slip rings are connected to an adjustable secondary resistance and the motor is started as a wound rotor induction motor. When the motor has come up nearly to synchronous speed, direct current is impressed at the slip rings and the rotor windings are used for field excitation. Motors of this type have excellent starting qualities, but are not as desirable in their synchronous motor action.

In starting a synchronous motor alternating voltage is applied to the primary windings. The resulting current sets up a flux which threads through the field coils. As these coils have more turns than the primary coils, the voltage induced in them may be very high, endangering their insulation. The potential induced at starting may be largely suppressed by short-circuiting the fields through the field rheostat. This procedure may reduce the starting ability noticeably. If the fields be shorted through a high resistance the danger to the insulation is eliminated without seriously affecting the starting torque. As the motor attains speed, the potential induced in the fields is reduced so that they may be safely connected to the exciting circuit. In some cases, however, the excitation may be placed on the field circuit and high resistance in parallel and the high resistance then cut out.

The potential induced in the field coils of a synchronous motor at starting is a function of the number of turns in these coils. If the motor be designed for high voltage excitation, its fields will comprise many turns carrying a small exciting current. A motor designed for a low exciting voltage will secure its ampere turns with less turns but heavier current. The less the turns the lower the potential induced at starting. Low voltage excitation is thus of advantage in this feature.

The "pull in" torque of a synchronous motor is slightly higher if its fields be partially excited. After the motor has accelerated to a point approaching synchronous speed—with fields shorted across resistance, they may be safely connected to the exciting circuit and the resistance eliminated. The excitation first applied should be considerably below normal and may then be brought up to that value corresponding to unity power factor under normal operating conditions. The motor should pull into synchronism operating in this manner with reduced primary voltage. Full voltage may then be impressed with minimum rush of current.

When the rotor is revolving without excitation in the revolving field set up around the stator, the rotor field poles are magnetized by the primary winding. The polarity of the field poles is a matter of chance. When direct excitation is applied to the field coils their polarity may not agree with that caused by primary excitation. In this case, the rotor will slip a pole so that the fields will have their correct relations. This will ordinarily be hardly noticeable, but, if undesirable, it may be avoided by applying reduced excitation before the rotor pulls into step, as outlined above.

The magnetic circuit of an induction motor is made exceptionally good in order to reduce to a minimum the exciting current which must be supplied from the primary lines. In a synchronous motor, the exciting current is relatively less important and the magnetic circuit is poorer, both due to wider air gap and interpolar spaces. At starting, induction motor action is relied upon. This means that the excitation is supplied from the primary winding. The magnetic circuit being poor, the exciting current is high. This is wattless current

and greatly reduces the power factor of the motor at starting. In starting an ordinary load, a motor of this type may take two or three times normal kilovolt amperes from the power lines. This implies that the motors on a system must not be too large in relation to the generating capacity.

The starting torque of a synchronous motor is not the same for all positions of the rotor. If the stator is star connected, the variation will not be pronounced. As the phases are in series, the currents are more nearly the same in all coils. In the case of a delta connection, the phase opposite the interpolar space may take excessive current.

The direction of rotation of a synchronous motor is determined by its revolving field, just as in the case of an induction motor. Rotation may be reversed by reversing any two leads of a three-phase machine or by reversing

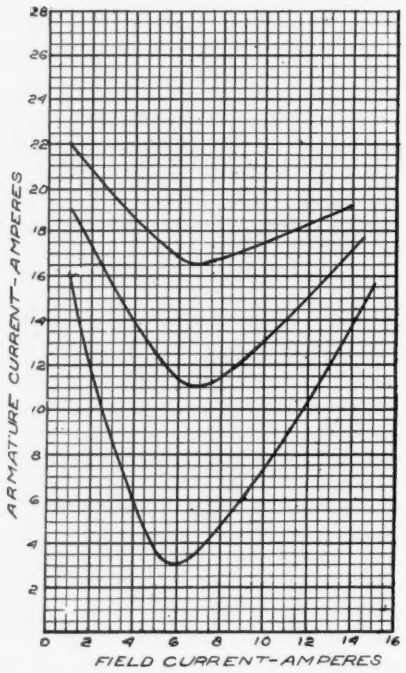


FIG. 5. VARIATION OF ARMATURE CURRENT WITH FIELD CURRENT IN SYNCHRONOUS MOTORS

one phase of a two-phase machine. A single-phase synchronous motor will operate in either direction, running in the direction in which it is started. Single-phase motors must be started by external means as induction motor action cannot be employed for starting on single-phase lines.

The pull-out torque of an ordinary synchronous motor with normal excitation is about twice full load torque. Any increase in load above this point will cause the machine to fall out of step and stall. The maximum torque varies as the square of the impressed voltage. Low voltage thus reduces the pulling capacity seriously. The maximum torque of a synchronous motor is greater if the fields be strongly excited than if the fields are under-excited. Over-excitation lessens the probability of stalling, but may limit the capacity due to the heating effect of the resulting wattless current.

The primary current of a synchronous motor is made up of load current, in phase with the voltage, and wattless current, out of phase with the voltage. The tendency is for a definite fixed flux through the stator and field poles. If the fields are under excited a wattless lagging magnetizing current will be drawn through the stator, tending to sustain the flux. If the fields are over-excited a wattless leading demagnetizing current will be drawn. Figure 5 shows the V curves of a synchronous motor, showing the effect of field excitation or primary current. At unity power factor the primary current is a minimum. This point changes slightly with different loads, the curves showing conditions with no load, half load, and full load, mechanical output. If a synchronous motor is operated solely to carry mechanical load, it should be excited to give unity power factor at full load or with slight overloads. At lesser loads a small leading current will flow. In well-designed motors, load changes do not greatly influence the power factor. Sightly over-excitation is particularly desirable on fluctuating loads subject to peaks, as a good pullout torque and stability on the peaks is thus secured.

If a synchronous motor is to be employed both to carry mechanical load and also for power factor correction, it must be larger than if it were to perform either service alone. The motor capacity may be expressed in kilovolt amperes and is limited by the heating of the primary winding. When a motor operates at unity power factor, there is no wattless current, all the current being effective for mechanical output. When a machine is operated as a synchronous condenser at nearly zero power factor, nearly all the current is wattless and the corrective effect is maximum. With combination service both load current and wattless current are taken. The resultant current should correspond to the kilovolt amperes capacity of the machine. The greater the margin between rated capacity and mechanical load, the greater the amount of corrective effect permissible. A combination unit is most effective when the mechanical load is about 70 per cent of the full rated horsepower capacity. With excitation adjusted to obtain rated full load current, the wattless component will be about 70 per cent of its value corresponding to use as a synchronous condenser alone. The power factor of the motor, with these conditions, will be about 70 per cent. It will be seen that dual service can be effectively attained without an excessive increase in motor size over that required for mechanical duty only.

The greatest advantage of the synchronous motor is its high power factor or corrective ability. The perfectly maintained speed may be advantageous in some cases. The efficiency is good at full load, but low at very light loads, due to excitation losses. At full load a synchronous motor is usually more efficient than a corresponding induction motor. The synchronous motor is well adapted for use on high voltage lines, having advantage over induction motors in this respect in that it usually has fewer and larger slots and is more easily insulated. The synchronous motor compares most favorably in cost with the induction motor in the larger sizes and lower speeds. The cost of the auxiliary equipment is proportionately greater for the smaller units.

In conclusion, it may be said that the synchronous motor has been developed to a point where its starting ability is considerable and its stability and reliability excellent. Its high efficiency and power factor are advantages which should justify its extensive use for continuous duty drives.

Boiler Repairs

PATCHING A BOILER. BY A. D. PALMER

A BOILER is patched because it has deteriorated to the extent that it can no longer be operated safely. If a return tubular boiler is allowed to become dirty, with loose scale, oil, or grease in the water, the shell will undoubtedly sooner or later bulge or bag.

Such a deformation of the shell is shown in Fig. 1 and in general it may be attributed to overheating of the shell, the internal pressure having forced the shell out at the bulged spot while in the overheated condition. If this condition is allowed to continue, the shell may be stretched to a point where rupture will take place, although it does not follow that a serious explosion will take place even under these conditions.

A little explanation in regard to the action of oil or grease in a boiler may better help the reader to understand just why such matters bag a boiler. Grease or like matters naturally adhere to metals. If a plate is absolutely clean of all foreign substances, no ordinary fire will burn that plate, as long as there is water on one side of the plate; but if the plate is given a coat of oil and heat is then applied to the plate, the water being held away from the metal by the oil, will afford no protection, and the plate will be burned. If this plate were the shell in the construction of a steam boiler, the internal pressure in the boiler would tend to push the spot softened by the heat outward, thereby causing a bag.

The area of a bag will, of course, depend upon the unprotected interior surface of the boiler. Such is the action of oil that a bag small at first may gradually come down until a whole sheet or course is down, in which case an expensive repair job is in order. Assuming that a small bag has been discovered, the correct steps to take are first to slow down the fires by banking; then as

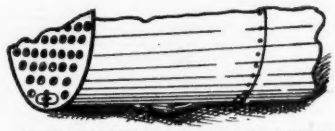


FIG. 1. APPEARANCE OF A BAGGED BOILER SHELL

soon as the boiler has cooled down, it should be blown off, opened, the source of the trouble located and removed.

If the bag is small, it may be forced back. To accomplish this, the defective plate is heated with a portable furnace or with blow-torches, and a jack with a face plate having the same curvature as the shell proper, is applied to the bag, gradually forcing it back to its original position, or shape. In performing this work care must be taken to nurse the bag back, that is, the outer edge should be forced back first and the center last. As far as possible the use of the sledge in doing this work should be avoided, and in general it will pay to have the work done by a skilled boiler worker.

Small bags are best let alone, care being, of course, taken that the direct cause and source of the bag is found and removed.

Occasionally a small bag will bulge to such an extent that it will be necessary to drill a hole in the low point of the bag, before rolling or forcing it back; this hole can, of course, later be plugged with a rivet, but it must be kept in mind that the metal is weakened at this point and it is a likely spot for trouble to develop.

Where the defect is of a very serious nature, it will become necessary to remove the bulged plate, and substitute a patch. However, before the injured boiler is touched in the line of repairs, there are certain very important factors which must be given consideration; viz., the character of the injury, extent of the defect, and the location, size the necessary patch will be, its thickness, and the arrangement of the rivets or the patch bolts. To all this it will be necessary to add a study of just how much the repair will reduce the allowed pressure the boiler will carry. Cases are on record in which we are told of expensive repairs having been made to boilers, only to prove worthless after the work was completed.

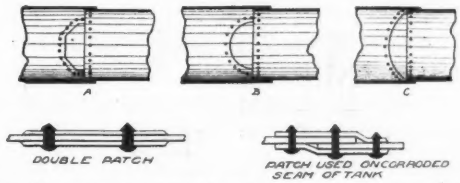


FIG. 2. FORMS OF PATCHES FOR BOILERS AND TANKS

A defect that is sometimes mistaken for bagging is blisters or laminations, which are generally met with in new boilers. This is actually a breaking away of a layer of the plate, and it might well alarm one not experienced with iron defects. A blow with the hammer will show the nature of this defect, the plate breaking away under this treatment, and if the lamination is of very considerable size a patch may be necessary, especially if the required pressure is high. The reason for this is that the actual thickness of the metal is reduced by the lamination. An outside patch is generally used in a case of this kind, applied with patch bolts.

In cutting out the defected portion of the plate the greatest care should be taken not to cut away any more of the original shell than is absolutely necessary, not to break the skin of the metal in other parts of the plate, and not to get grease or oil in the boiler. A hole the shape of the patch should be cut, and insofar as is possible this hole should not have a side running in line with the longitudinal seam of the boiler. For this reason, no patch having square corners should ever be used; but in general it may be said that the shape of the patch will depend wholly upon good judgment, and the particular job on hand. It should be kept in mind, however, that while a boiler may be designed with a joint efficiency of as high as 96 per cent, yet it is quite possible to cut the efficiency down to below 50 per cent by a poor job of patching. This will, of course, result in a cutting down of the allowed pressure on the boiler, possibly making the boiler useless for that particular plant.

Three forms of patches are shown in Fig. 2; in A, the patch plate forms a single riveted lap joint on the longitudinal plane of the shell, and as already explained this must be avoided if possible. Patch B is better, but C is the proper shape which a patch should have, and

wherever possible this should always be used. It is not always possible, however, for if the bag extends along the bottom of the shell for some distance, this form of patch will actually mean putting a new course in the boiler. For this reason, the forms A and B are sometimes used. Where the boiler is fitted with a manhole under the tubes, it is possible to use a round patch; but this will be possible only where the hole cut is less than the greatest diameter of the manhole.

Patches are applied to both the inside and the outside of a boiler and it is a question much discussed just which form of patching is the better. A patch put on the outside of the boiler is known as a soft patch, and is generally applied over the defective part of the shell and this is generally looked upon as a temporary job. This patch is seldom riveted on, being held in position

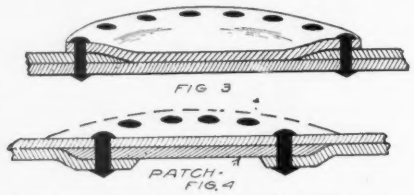


FIG. 3. BOILER PLATE SCARFED TO ACCOMMODATE PATCH ON SMALLER COURSE

FIG. 4. PATCH SCARFED WHEN LARGER COURSE IS DEFECTIVE

by patch bolts. Inside or hard patches are applied from the inside of the boiler and are always riveted on to the shell and must be calked tight.

If the defective portion of the shell is cut away and an outside patch is applied, a pocket is formed wherein scale and dirt may collect, causing further bagging. The shell edge where the rivets are located, however, is well protected by the water, and should fire cracks develop in the patch causing leaks that cannot be stopped, it is only necessary to remove the patch and replace it. If an inside patch is used, the plate edge is exposed direct to the fire, and should cracks develop, the plate must be cut out, making a bigger hole in the boiler, a larger patch, and a poorer job each time it is done; however, the pocket is eliminated in this case.

In order to insure a tight fit the patch should be made with the same curvature as the shell upon which it will be attached, the rivet holes should be drilled with the patch bolted up in position, after which it should be removed from the shell cleaned of all burs and oil.

If the patch is of the inside type, it must be kept in mind that the lap of the plate must not be greater than 1½ times the diameter of the rivets, as a greater lap than this will generally result in burning of the unprotected lap, which burned portion will have to be removed, resulting in a larger patch.

A double or inside and outside patch should never be used in boiler work. Such a patch may be useful in repairing corroded shells of tanks; but where the repair is exposed to the action of heated gases, as in the construction of a steam boiler, it will only mean that the patch itself and possibly the shell under the patch will ultimately be burned, resulting in further repairs. For this same reason, heavy plates and double riveting are seldom used in patching, because here again the matter of insufficient water protection come into the question.

Quite often, a bag will develop just in front of the first girth seam, right over the fire. The reason for this is that the smaller inner course forms a pocket in which scale collects and as this location is the hottest part of the boiler, a bag is the result.

Assuming that the bag is adjacent to the girth seam and is serious enough to require cutting out, the proper form of patch for such a repair will be the horseshoe, or crescent patch. In cutting out the injured plate, a number of the girth seam rivets are removed and the rivets which replace these will tend to hold the patch in place. When the crescent patch is applied to the inside of the smaller course in a boiler, it is necessary that the shell plate be scarfed down to make a snug fit. See Fig. 3. But if the patch is applied to the larger course, then the patch must be scarfed, as in Fig. 4, the inner and outer courses being forced apart enough to allow the patch to come between them.

When the shell plate itself must be scarfed, the work must be done on the cold metal, and it consists mainly in tapering down the edge of the sheet with a cold chisel. The idea is to remove the sharp corners that would cause offsetting of the patch, and to give easy turns to the metal. If the patch, however, has to be scarfed, then the work can be done while the patch is heated, and actually consists of hammering the metal out.

Before the patch is applied the greatest care should be taken to ascertain that all the damaged metal has been removed, and where cracks have developed this is doubly important. For this reason, the boiler around the location of the patch should be very carefully cleaned before any drilling is done.

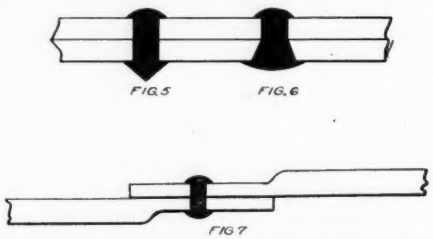


FIG. 5. RIVET HOLES SLIGHTLY CHAMFERED

FIG. 6. HOLES COUNTER SUNK

FIG. 7. BEVELLED SEAM

There are a number of methods used in drilling the holes for the rivets in applying a patch. In one the holes are drilled in the plate, and a paper templet is then made from these holes for drilling the patch. This is bad practice, as too often the holes do not come true, resulting in the use of the drift pin, which is something which should never be tolerated in boiler practice. A better method is to make a number of holes in the shell and the patch, and then with the patch bolted up in position, drill all the holes. Still another method is to drill small holes in the patch, bolt it up in position, and then drill the full size holes running through both patch and plate.

As far as is possible, the pitch of the rivets in a patch should be uniform. One method of insuring this is to lay out one-quarter of the holes, and then lay out the rest of the holes accordingly. In replacing the rivets in

a girth seam where a crescent patch has been provided, the same pitch will be used as in the rest of the seam, and this will mean that the pitch of the rivets in the patch will have to conform with the girth seam patch.

It is not advisable to have the rivet heads of excessive size, especially where such rivets are exposed directly to the action of the heated gases from the fire, as at the first girth seam which is a common spot for bagging to occur. If it is necessary to repair the boiler in the plant where it is located, and the rivets are hand driven, then the holes should be slightly chamfered and the heads formed as in Fig. 5. Still another method used, but not commonly, is to countersink the holes as in Fig. 6. The great point to be kept in mind is that as little of the head of the rivet should be exposed to the fire as is practical, for the less the rivets and plates are so exposed the less will be the trouble with fire-cracks and leaky seams. Still another method of keeping the plate edge and rivets from burning is to bevel down the plate as shown in Fig. 7, but this actually applies more to the use of heavy plates in the construction of boilers than to repair work.

It is obviously the work of the experienced boiler inspector to design and lay out the patch, as it will

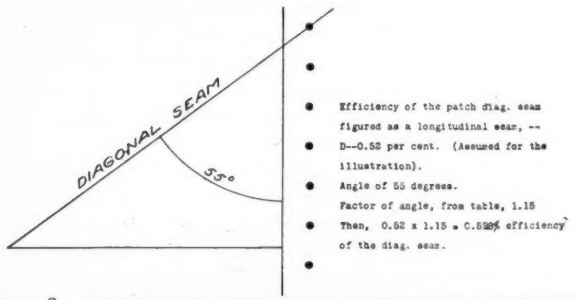

DIAGONAL SEAM
55°
Efficiency of the patch diag. seam figured as a longitudinal seam, -- D--0.52 per cent. (Assumed for the illustration).
Angle of 55 degrees.
Factor of angle, from table, 1.15
Then, 0.52 x 1.15 = 0.598% efficiency of the diag. seam.

FIG. 8. METHOD OF DETERMINING EFFICIENCY OF PATCH JOINT

fall to him to set the safe pressure the boiler may carry after the repair work is completed. Different boiler boards and boilermakers have different methods of finding what the allowed pressure will be after a patch is applied on a steam boiler, but the following is a simple method and gives very good results.

First determine the efficiency of the diagonal joint of the patch as if it was a longitudinal joint. Then ascertain with a protractor the angle the diagonal seam makes with the girth seam. The reason for this is that the efficiency of a diagonal seam varies according to the angle the joint makes with the circumferential seam With this information one may refer to a table of factors of angles, and by taking the corresponding factor for the known angle, a constant may be obtained which if multiplied by the joint efficiency as first obtained will give the efficiency of the patch joint. Expressed as a formula we have:

$$D \times F = J$$

in which D = efficiency of diagonal joint as a longitudinal joint.

F = factor of angle.

J = actual efficiency of the patch, or diagonal seam.

The following table gives those factors of angles most commonly met with in practice:

Angle	Factor
28	1.57
30	1.51
35	1.42
40	1.34
45	1.27
50	1.20
55	1.15
60	1.11
65	1.08

In Fig. 8 the method of using this formula is plainly given, with a practical example to illustrate how the work is done.

In finishing up a job of patching it is of vital importance that the joint be calked absolutely tight, as a leak very slight at first may cause corrosion which will practically make calking impossible. If the patch is of the outside type the patch itself is calked to the boiler, but if the patch is an inside patch then the shell plate is calked. It is hardly necessary to say that a round nose fuller is the proper tool to use for this work.

Refrigerating Economies

LOSSES, WHERE TO HUNT THEM, HOW TO STOP THEM, IN COMPRESSOR ROOM, PIPE LINES AND COOLING ROOMS. BY PETER NEFF

TODAY we are face to face with conditions that are demanding more efficient operation in all industries. Refrigeration is especially affected, in that it is asked to conserve both fuel and ammonia, the two prime factors in its production. Therefore it may be well to consider some of the ways in which it is possible to accomplish results more economically.

Direct losses by leakage are self-evident and should not be tolerated in any plant.

HEAT LOSSES

REFRIGERATION involves the transference of heat, and as this transference takes place in all plants at temperatures both above and below the normal, care must be exercised that losses do not occur. Moreover, these losses are not apparent but must be sought out.

Fuel is consumed to generate power, which in turn is converted into refrigeration, with possibilities for losses from the beginning to the end of the process. Frequently these losses are individually small, but they are continuous, and like interest know no rest, nights, days nor Sundays; they are cumulative and in the aggregate are large.

To combat a heat loss we employ insulation, and it is suprising how often little attention is paid to this. Steam pipes are run uninsulated, notwithstanding the fact that a bare pipe will have a loss of approximately 2.7 B.t.u. per sq. ft. per hr. per deg. of average difference of temperature; whereas this can be reduced to from 0.3 to 0.5 by proper insulation; and this insulation can be applied at any time.

The loss from exposed cold pipes comes under the same category as that from steam pipes, but here the insulation cannot be applied unless the pipes are dried off. In many plants where the cold pipes are insulated one will notice a breaking of the covering; this is pri-

marily due to the placing of the pipe hangers. These should be outside of the insulation. If they run through it, moisture will follow the hanger, ultimately reach the pipe, freeze and split the insulation. Poor insulation is almost as bad as none; all that it does is to give the owner an excuse to say that his pipes are covered.

Room Insulation

A harder problem is the insulation of the rooms or tank where the refrigeration is applied; here it is a most essential thing, but if neglected when the plant was installed, it is next to impossible to correct the evil without involving heavy expense. Where this condition exists, the only thing to do is to minimize the loss as much as possible.

A brine tank may be so poorly insulated that the losses when the brine is very low will neutralize the work done on it. In such a case, the only remedy is to find out how low temperature the brine must be to accomplish the work, and make no attempt to lower it beyond that.

In cold storage rooms the same thing applies. Do not carry them at a lower temperature than is absolutely necessary for the work in hand. Look after the doorways; frequently at the bottom of the door a current of cold air will be passing out. Not only is this a direct loss, but it helps on another trouble. For every cubic foot of cold air that passes out, a corresponding amount must be taken into the room, usually through small leaks about windows, tops of doors, cracks and loose insulation. This air brings with it moisture which is most readily deposited on the ceiling.

A common trouble is usually found in the top floors, where a ceiling made of boards and paper has been put on the underside of the joists, with perhaps mill shavings, ground cork or something of that nature placed between the joists. This type of insulation is not air tight. As the cold air passes out of the room there is a tendency to draw air in at the ceiling; a small crack or a nail hole is sufficient to start the trouble. As the air enters, its moisture is deposited and sooner or later a wet spot develops, which swells the wood, enlarging the crack, and the usual trouble is well under way.

To avoid this, the ceiling should be hermetically sealed and this is usually most easily accomplished by placing some form of sheet insulation on the floor above and thoroughly pitching it, then if a small leak should develop, fix it.

Doors are always a source of loss, and all one can do is to minimize the opening of these, and to see that they are tight.

Do not refrigerate more space than is necessary. Often one or two rooms can be cut out of service.

Regulate Machines to Load

Never use two machines when one can be made to do the work. In some instances it is thought necessary to carry two suction pressures. Remember, that low temperatures are costly. In some instances it has been found that the low temperature rooms could be carried a little higher; and that by keeping the pipes defrosted and flooding these coils the room could be held with a suction pressure of from 12 to 15 lb., and this could be used throughout the plant.

It is well always to try to operate a machine at full capacity; in case a brine system is used, it is often possible to cool the brine, and then shut down the machine for a time, and when the brine has risen to a point where it will not do the work, run the machine and knock it down again. The same thing is true in direct expansion work; frequently several hours shutdown may be made without causing any damage. The goods in a room will not change as rapidly as the room temperature.

Ammonia Receiver

A most common source of loss is in not keeping the liquid seal in the ammonia receiver. So much has been written on this that it would seem useless to mention it, but it is still in evidence in many plants. If the liquid is drawn down in the receiver until the outlet is exposed, then some uncondensed gas will pass through with the liquid. This gas has not only been handled once by the compressor, but in putting it in to be handled over again it carries with it additional heat which the compressor must ultimately handle, increasing the cost without accomplishing any good.

In most cases the ammonia receiver is too small, making it impossible to carry a sufficient charge to maintain a proper working condition under varying conditions of operation. This is especially noticeable in plants having double pipe type of condensers, as in that case the condenser offers no appreciable space for the storage of ammonia. The receiver should have a gage glass, and this should be used. A larger receiver will often cure half the troubles in a plant.

In installing a new receiver, it should be arranged so as to act as a separator for oil and other impurities. This can be done by keeping the outlet above the bottom, thus leaving a space for the oil, etc., to accumulate, and from which it may be removed. The passing of oil to the evaporator side of the system is a source of trouble, and a receiver made as suggested is an additional guard against it.

When the ammonia leaves the condenser it should be as cold as is possible with the type of condenser employed. In some instances it is considerably below the temperature of the atmosphere of the room where it is stored. It thus becomes heated on its way to the feed valves, and the machine has to take care of this extra heat. It is well in such cases to insulate the liquid line and either insulate the receiver or move it to a cooler place.

On the other hand, it sometimes happens that a plant has a small amount of cold water, but has to use water for the condenser at a high temperature. In this case a saving can sometimes be made by cooling the liquid ammonia on its way to the feed valves by means of the cold water available.

Thermometers

In all these problems temperature plays a part and must be known, and it cannot be unless the plant is supplied with thermometer wells. Thermometers on the suction and discharge of the compressor are indispensable to the economical operation of a plant. For a case in mind the suction gas was at about 60 deg., yet the warmest place where it passed was about 30. This condition pointed to a leak of hot gas, and it was found in the by-

pass valve used for starting. Only a thermometer could have detected this.

In regular operation, it is important to know the condition of the suction gas. Much superheating is not economical, neither is a condition where the gas is carrying entrained liquid. The saturated condition is the ideal, but it is impractical without proper arrangements on the suction line. It is usual to run with a few degrees superheat, but without thermometers one is helpless in regulating the matter.

An unusually high temperature of discharge, for the conditions existing, should lead to an investigation of where the trouble is.

Electric-Driven Pumps

Steam pumps and air compressors are large steam users. Where this service can be obtained by the use of electric motors, the current being obtained from an economical unit, a saving can be made. Where this is impracticable, the pumps must be kept in good condition, and their use restricted to that which is absolutely necessary.

If in a well-equipped and well-managed electric plant they are only able to get about 10 per cent of the heat units in the coal converted into kilowatts, what must the loss be in refrigerating plants that offer such opportunities for heat wastage.

Our aim has been to call attention to some of the many places where small losses may occur, but the human element in all plants cannot be overlooked, and it resolves itself into a matter of careful attention to the little things, a desire to gain all the knowledge possible of the underlying principles involved and the application of this knowledge to the individual plant.

Plant Operation

Employees Instructed in the Mechanism and Operation of Machinery and Apparatus an Aid Toward Increased Efficiency. By H. A. Fisher.

MODERN power plant equipment has been brought to a high state of efficiency in the past few years, and though no doubt many improvements will still be made, future improvements will come much slower than those we have witnessed in the past few years. Such improvements as will be made cannot immediately improve the efficiency of the existing plant without considerable expense and probably the discarding of already efficient equipment.

Since the inherent efficiency of the equipment cannot be easily increased, attention must be turned to methods of increasing the operating efficiency. Inasmuch as the operating efficiency depends almost entirely on the knowledge the operating man has of the apparatus in his care, an effort should be made to increase the operator's knowledge of the machinery of which he is in charge and to systematize and standardize everyday operating methods.

It seems poor policy for a company spending thousands of dollars annually, instructing the public in the mechanism of electrically operated machines that it sells to install machinery costing thousands of dollars in its power plant, without so much as furnishing the men who are to operate the new equipment, with the manufacturer's catalogs and instruction bulletins. Yet this is being done daily.

The practical man probably has no greater enemy than some of the men of his own class who have risen from the ranks. A great many of these men through their petty jealousy and self-esteem make every effort to keep their fellow workers and employes ignorant of the very things they should know. Thus, when new machinery is installed in a plant in charge of a man of this calibre, all the blueprints, bulletins, manufacturer's catalogs and other sources of information that should be available to the men who are operating the machine are confiscated by the man in charge of the narrow-minded idea of increasing his own knowledge and prestige over that of his fellows, or keeping the information from them so that they may not increase their knowledge above his. The management in most cases is ignorant of the real conditions that are going on, but in the eyes of the law "ignorance is no excuse," therefore in order to educate their employes, executives should become acquainted with conditions as they actually exist and introduce a practical and systematic form of instruction.

Probably the greatest fault in the methods of instruction that are being used by a few companies to aid the operating men is that the courses are prepared by men who are not thoroughly familiar with what the practical man needs to help him most in his everyday work. This is the cause of a great deal of energy being wasted by the instructor and instructed. The universal method or system of instruction consists of a series of lectures or talks given by college professors or technically trained engineers who are wasting time lecturing on the theory of power plant economics, to men who in a great many instances are not familiar with the apparatus which they are operating. This educational work is usually too broad and advanced to apply to the problems which the practical man must solve daily.

Costly breakdowns and serious interruptions of service would many times be prevented if the operator thoroughly understood all the constructional details of the machinery in his care. The instruction and aid that the practical man needs most to enable him to increase the operating efficiency of the modern power plant, is that which will acquaint him with the constructional details and the best methods of operating the machinery in the particular plant in which he is working.

The system which in practice will benefit the employe and the employer the most, will be one that will familiarize the operator with the working theory of the machine, the correct names, positions, actions, relations and adjustments of all the various parts, the proper method of dismantling and assembling the machine when making inspections or repairs, proper operating methods, most likely causes and remedies of troubles that may arise while the machine is in operation, and finally the running of tests by the men on the machinery which they are operating. Lectures by professional engineers to give the men a chance to broaden their minds and incite their initiative will also be helpful.

In practice, the system would be worked out about like this: Pamphlets and leaflets—to be inserted in loose-leaf books of a convenient size for the pocket—would be prepared, containing outline and sectional drawings of each important piece of apparatus. The

different parts would be shown in their correct positions and lettered or numbered. Below the drawings the reference letters or figures would be arranged in columns with the proper names—preferably the manufacturers' names—of the part, to which the letter or number referred, following it.

Following the drawings and nomenclature of the machine a text would be written, describing the functions and adjustments of the various parts. The proper methods of operating, dismantling, repairing and assembling the machine would also be described in detail, making a special effort to standardize these operations. To realize the most good from this system of instruction — and I might add, standardization — the smallest details must be carefully considered. As an example, take the work of dismantling an engine or turbine for inspection or repairs, a complete description of this work would be given, stating the proper point at which to start the work, the sizes and styles of wrenches necessary for the work—these should be given a number or symbol in the description and a like number or symbol be stamped on the wrenches and other tools—the proper hitches and rigging necessary for balancing and lifting such parts as would have to be handled with a crane, and all the necessary details pertaining to the work of inspection, repairs and adjustments. This detailed description of the proper methods of proceeding with the work would be taken from what had been found from past experience to be the most efficient method of accomplishing the work. As better methods were discovered and new rules formulated, new instruction sheets would be issued, thereby keeping the work revised with the latest and best practices. A system of instruction such as outlined above should do much in the eliminating of guess-work, indecision and continuous repetition of poor practices such as are unfortunately prevalent in almost every power plant.—Industrial Management.

Belt Economics*

By W. F. Schaphorst

IN LINE with the advance of other materials, belting is holding up its end also, and it is more important than ever that we study belts and power transmission with the utmost care.

It is a well known fact that a double belt, for instance, will not transmit twice as much power as will a single belt, even though it is twice as thick and twice as strong. The reason is, a single belt has just as much contact with the pulley as has the double belt, and it is the contact that counts. Besides, the single belt is more flexible. It is also a well known fact that double leather belts cost twice as much as single leather belts of equal width. In view of these facts, therefore, you will readily understand why single belts may often be the most economical selection, even though you may have to buy wider pulleys to accommodate the wider belts.

I will outline the manner in which belts and pulleys should be selected to effect the greatest economy:

First, decide on the kind of belt you are going to use, whether leather or solid woven cotton, or other fabric material. The substitute belt is coming into wide usage these days on account of the high cost of leather, and in some fields has completely replaced the leather belt. However, there is nothing better than leather for drives where shifters are used, because shifters are rather hard on fabric, tending to unravel the edges and giving the fabric a tattered appearance. On overhead or open drives, where there is no such cutting or wearing obstruction, the substitute belt does very well indeed.

Second, determine the cost of a single belt or equivalent in the substitute belting for transmitting the power that must be carried. This is easily done by multiplying the horsepower to be transmitted by 800 and dividing by the speed of the belt in feet per minute. This gives the width of the belt in inches. Now consult the manufacturer's catalog and determine the cost of such a belt of the needed length.

Third, determine the cost of the pulleys required for the single belt. The pulleys should be a bit wider, of course, than the belt, and they should be strong enough to withstand the load. It is a simple matter to find the cost in any pulley manufacturer's catalog.

Fourth, determine the cost of a double belt or equivalent in the substitute belting field for transmitting the same amount of power as above. This is done by multiplying the horsepower to be transmitted by 500 and dividing by the speed of the belt in feet per minute. This gives the width of the belt in inches. Now consult your manufacturer's catalog and determine the cost of such a belt of the same length as a single belt.

Fifth, do the same as instructed under "Third."

Sixth, add the cost of the double belt to the cost of the pulleys for the double belt and you have the cost of a double belt drive.

Seventh, compare the cost of the single belt drive with the cost of the double belt drive and you can about decide the question without any further ado. I have investigated cases where considerable money could have been saved by using single instead of double belts. And when it comes to using triple belts, the saving is even more marked. In general the above method of computation will show the single belt drive to be the most economical, the double next, and so on. The thicker the belt the poorer the transmission power per dollar invested.

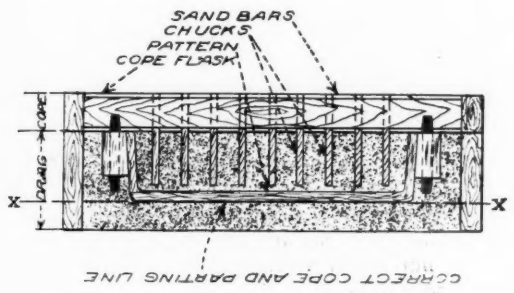
As for what thickness is best, we often read inflexible statements with reference to belts, that a double or triple belt must be used on such and such a drive. Statements of that kind are often far from the truth. I am not stating here what is best. I merely submit these data for your consideration and you may use your own judgment. I will add, in closing, that thick belts should never be used on small pulleys. The reason is obvious.

*Copyright by W. F. Schaphorst.

Tearing up city streets in order to sell the paving material is being seriously considered by the city officials of Butte, Mont., according to advices from that city. A few years ago some of the streets were paved with manganese ore, which at that time was considered worthless. Since then the war has caused a heavy demand for manganese, and the manganese rock used for paving is now valuable.

Pattern for Motor Base

IN THE CONSTRUCTION of a pattern for a "motor base" I made a mistake. Like mistakes are frequently made by pattern makers, however. I had followed the instructions given on the drawing, but when the pattern reached the foundry the molder objected to the way in which it was made because of the trouble it gave him in the making of the mold; he also told me why and how the trouble could be corrected in the making of like patterns in the future. I was particularly interested because this is a class of patterns that the pattern maker is often called upon to make. I will not attempt to show the exact design of the pattern wanted, but rather make it plain so as to aid me in my description. The pattern was for a "motor base" and measured 4 ft. square, 6 in. deep inside, thickness of metal 7/8 in. The draftsman made the drawing with 3/16-in. taper on the sides of the base (this is what caused all the trouble), thinking that by so doing he was aiding the



CROSS SECTION OF PATTERN IN MOLD

molder to extract the pattern from the mold. His intention was very good, but this is a mistake that is being made in drafting rooms and in pattern shops every day. As there was but one casting wanted, making the pattern with straight instead of tapering sides would have made the work of molding the pattern an easy job for the molder and without any special rigging in the cope flask and the casting thus produced would have answered every requirement. With the sides of the pattern made tapering, the inside was molded in the cope. The heavy body of hanging sand must be secured to prevent a drop in the mold; this was accomplished by means of chucks especially fitted and fastened in the cope for this one job or casting. This and the work of making the mold, added to the expense of producing the casting. The sketch is a cross section through the pattern and the mold. In this is shown the molding of the pattern with the tapering sides, the heavy body of hanging sand, the sand bars, the chucks in the cope. From this it can be easily understood what a slight change in the construction of a pattern means to the molder. Now, just turn the sketch upside down. With the sides of the pattern made straight the whole pattern could be molded in the drag, the parting made on the line "X X," any old flask will answer for the cope without any special rigging, the pattern can be molded in shorter time and with much less labor. The weight of this casting was about 2200 lb.

M. E. DUGGAN.

Temperature of Furnace Air and Flue Gases

I HAVE READ with interest Mr. Schaphorst's article entitled "Temperature of Furnace Air and Flue Gases."

This is a very timely subject and one in which all of us should be interested. The conservation of fuel resources and the saving of every possible portion of potential energy in the form of fuel should engage our first thoughts, and too much cannot be written on this vital subject.

In the presentation of the article there are, however, several points which are rather misleading, in that they do not convey quite the correct meaning. Quoting the statement in the fifth paragraph as follows, "Inasmuch as 0.24 B.t.u. is required to raise the temperature of 1 lb. of air 1 deg. F., it is evident that much of the heat value of the pound of coal is lost in simply bringing the temperature of the cold air up to the temperature of combustion. For each degree $(0.24 \times 18) = 4.32$ B.t.u. are lost. For each 100 deg. F., 432 are lost. If the heat value of the coal is 10,000 B.t.u., this preheating therefore represents a loss of 432 divided by 10,000, or 4.32 per cent."

From the foregoing paragraph, it would appear that preheating results in a loss, while the intent of the author was, no doubt, to show that it gave a gain.

The temperature of combustion is dependent upon the heat value of the coal, pounds of air supplied and specific heat of air, and the heat spoken of is not lost in bringing the temperature of the cold air up to temperature of combustion, but the loss is due to the fact that full advantage is not taken of the gain resulting from the higher temperature of combustion obtained by the preheating: for the higher the temperature of air supplied, the higher the theoretical temperature of combustion above 32 deg. F. and the theoretical efficiency will be.

The efficiency being represented by $\frac{T-t}{T}$ in which T is the temperature of combustion and t the temperature of water in the boiler, as it is obviously impossible to reject the gases at a lower temperature than that of the water in the boiler, it follows that the greater range

between the two temperatures, the higher will be the maximum theoretical efficiency.

Let H equal the heating value per pound of coal, c equal specific heat of air, p equal pounds of air supplied per pound coal, T equal elevation of temperature above air supplied, and t equal temperature of water in boiler above air supplied. Since $\frac{H}{cp}$ and T both equal elevation of temperature of combustion above air supplied

$$\frac{T-t}{T} = \frac{\frac{H}{cp}-t}{\frac{H}{cp}} = \frac{H-tcp}{H}$$

which represents the maximum theoretical efficiency of heating surface. Using the values given by Mr. Schaphorst of 10,000 B.t.u., 18 lb. of air, and assuming the temperature of water and air 360 deg. F. and 60 deg. F. respectively, then t = 360 — 60 or 300 and

$$\frac{H-tcf}{H} = \frac{10{,}000-(300\times 0.24\times 18)}{10{,}000}$$

equals 87 per cent. Let the air be preheated 100 deg. F., then

$$t = 200 \text{ and } \frac{H-tcf}{H} = \frac{10{,}000-(200\times 0.24\times 18)}{100{,}000} =$$

91.4 per cent, a gain of 4.4 per cent in the maximum possible efficiency, practically the same per cent gain as given as a loss in the article.

Undoubtedly preheating can be used as a method of increasing the efficiency, but whether the necessary outlay for fans, ducts, etc., can be kept within an amount on which the saving will show a fair return on the investment is the question. There are, however, so many factors which affect the economical operation of a boiler plant, to which close attention must be paid, and if not the effect of preheating and any other refinements will be entirely nullified. The most important one is probably the rate of air supply. A minimum amount of 18 lb. air per lb. of coal is probably for average coal the most desirable, below this amount, losses due to incomplete combustion may result. It can be seen from $\frac{H}{cp}$ = elevation of temperature of combustion that the number of pounds of air supplied is the decisive factor for any given coal. Assuming a coal of 13,000 B.t.u. and a temperature of atmosphere of 60 deg. F., the furnace temperature with 18, 20, 30 and 40 lb. of air would be 3069, 2768, 1865 and 1414 respectively. From the above temperatures it can readily be seen the effect that excess air will have upon the efficiency of the boiler from the very large drop in the temperature of the fire and inasmuch as the efficiency will depend upon the range of the temperature limits, viz., $\frac{T-t}{T}$, it is obviously necessary to obtain as high an initial and low a final temperature as possible.

The latter condition means that close attention must be paid to the cleanliness of the heating surface, both internal and external, in order to keep this temperature as low as possible. This final temperature is also affected by other factors, apart from the cleanliness of the surface. For instance, at high rates of driving, wherein the evaporation per square foot of heating surface is high, it will mean that owing to the increased volume and velocity of the gases, their final temperatures will be higher, even with the air supply near the theoretical amount, as it is manifestly impossible to change the amount of heating surface with each increase in rate of gas flow through the boiler.

It follows that there must be some point at which the boiler can be operated most economically; that point must be determined by actual test and will depend upon many variable factors, chief among which is the rate of air supply.

If the boiler plant consists of a battery of more than one boiler, and should the character of the load call for a varying steam supply, it will be most economical to operate the greater number of boilers at this point of maximum efficiency., taking care of the fluctuations in steam demand by one or two floating boilers, operating the rest of the boilers with constant furnace conditions—that is, air and coal supply and constant feed water supply.

Another point that will bear very close watching for its effect upon the final temperature is the method of baffling of boilers. This has a very decided effect upon the final temperature of gases and capacity of boiler. The areas of openings through the gas passages must be carefully determined, so that the rate of flow, or velocity, is constant through all passages, so that no pockets or dead spaces are left where circulation is poor. Areas too small will result in restricted gas flow and excessive draft loss through boiler. In horizontally baffled boilers where cross-sectional area at right angles to the tubes is large compared to area of openings through the baffles, an appreciable amount of heating surface is often ineffective where the number of vertical tubes between horizontal baffles is more than eight. The design of baffle must be such as will permit all parts of heating surface being in contact with circulating gases. The baffles must be kept in the best possible condition, careful attention being paid to openings around tubes, so that there is no short-circuiting of gases.

The various factors affecting the economical operation of the boiler plant can be summarized somewhat as follows. Those due to design of plant and those which can be considered as operating factors. First under the heading of design will come furnace and combustion chamber dimensions, method of baffling construction of boiler walls (controlling radiation losses). Operating factors can be subdivided to those which the fireman can control and others which are strictly operating factors, but for which the fireman cannot be held accountable, as they are really part of the responsibility of engineer or fire room foreman. Under the first heading will come:

(1) Loss due to incorrect air supply.

(2) Loss due to cleaning of fires, where large amount of unconsumed coke may be taken from fire.

(3) Loss due to dirty boilers, externally, soot on

tubes. (In plant of moderate size, fireman's duties often include blowing of soot from tubes.)

(4) Loss due to lack of care in feeding water to boilers.

(5) Loss due to lack of equalization of load on boilers.

Under the second heading will come:

(1) Loss due to leaky boiler settings, infiltration of air through brickwork and door fittings.

(2) Loss due to dirty boilers internally, scale and on heating surface.

(3) Loss due to leaky baffles.

(4) Loss due to banked fires.

(5) Loss due to leaky blowoff valves.

R. TAYLOR.

Oil Burning

I WAS MUCH INTERESTED in John Pierce's article on oil burning, which appeared in the May 15 issue of Power Plant Engineering.

I have been burning oil for a number of years, and have also visited other plants. I have tried out a number of plans for burning oil, and got the best results when I tore out the bridge-wall entirely down level with the grates, and let the ashes rise about 4 in. from there to the rear end of the boiler; then I plastered the grates over solid with fire clay about an inch thick back to within 10 in. of the deadplate. This arrangement is for a return tubular boiler 60 in. in diameter and 18 ft. long. I find very little difference in burners; what is wanted is a burner that will spread the flame over as much heating surface as possible. I never allow an oil flame to touch the boiler directly; the closer it hugs the ashes below the boiler the better. I have never found it necessary to carry over 30 lb. oil pressure; this will require a little wider opening of the oil valve at burner, which lets small particles pass through without choking the valve when you are burning dirty oil.

It seems that Mr. Pierce regulates the air to the furnace entirely by the ashpit doors; this is wrong; regulate by the damper in the stack; you can run with the damper almost closed and there will be no streams of cold air rushing in through openings in the boiler setting. I made a test with damper wide open, burning 32 bbl. of oil in one day; I then closed the damper as close as possible to run with it and burned 25 bbl. in the same length of time and with the same load.

I do not think there is anything gained by heating the oil; but in burning oil from the refineries I have had considerable trouble in drawing it from the tank in cold weather, as it seemed to adhere to the suction pipe until it would almost close it up; but laying the exhaust line from the oil pump alongside the suction pipe did away with this trouble. I would like to hear from others who are burning oil. READER.

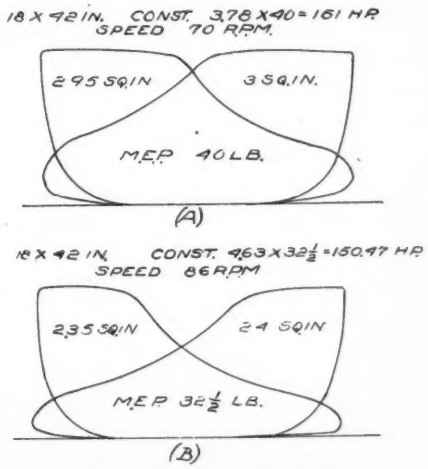
Securing Increased Horsepower

IN A CERTAIN PLANT there were installed two engines, one a 14 by 36-in. Putnam operating at 78 r.p.m. and the other a crab claw Corliss, 18 by 42 in. and running at speed of 70 r.p.m.

The latter frequently refused to cut off and I was told that the work had outgrown the engine and that the purchase of a new one with a 20-in. cylinder was under consideration. Upon investigation I found that the Corliss engine had a constant of 3.78 and at a mean effective pressure of 40 lb. was developing 151 hp.

The steam valve showed ¼ in. lap with the wristplate centrally placed and with the valves hooked up; compression was up to about 90 per cent of the boiler pressure.

Of course, there are several factors tending to increase the power of an engine when the boiler pressure cannot be increased, each of which I tried separately. First I placed the wristplate in a central position and changed the steam valve links so as to obtain ⅛-in. lap with valves hooked up and, of course, set back my eccentric ¼ in. on the shaft. This had a two-fold effect. It increased the range of cutoff, allowing the valves to hold on longer before meeting the knockoff cam and also decreased the compression to 70 per cent of the boiler pressure.



(A) CARD BEFORE MAKING CHANGES
(B) CARD AFTER MAKING CHANGES

In trying out the engine I discovered that the steam valves did not refuse to trip half as often as before the change. I next changed the exhaust links from ⅛ in. lap to line and line with the wristplate central. This had an effect equivalent to all the previous changes because it gave opportunity to secure increased mean effective pressure and card area.

The engine would now very rarely refuse to trip its valves because it was loaded within its range of cutoff. I do not like the idea of so little compression except when an engine is working within its range of cutoff on account of the increased cutoff required to secure the compression desired, notwithstanding that filling 7 per cent clearance does not require even one-half that in increased cutoff, a fact I have proved by accurate experiment. So in order to continue with the former high degree of compression, there was but one thing to do.

By increasing the speed of the engine from 70 to 86 r.p.m. and with a constant of 4.63 and a mean effective pressure of 40 lb., I was able to secure with the same cutoff 185 hp. instead of 151 hp. Now, since the engine was required to develop only 151 hp., the cutoff was shortened so as to reduce the mean effective pressure to

32½ lb., which, times the constant of 4.63 at 86 r.p.m., provided 151 hp. with a reserve of 34 hp. for possible future requirements.

By utilizing a larger jack shaft pulley, the main factory shaft turns at the same speed as does also my governor, with its larger pulley; the engine runs smoother and everybody is satisfied—especially in view of the fact that we are now saving 2½ tons of fuel each week.

Cards A and B show conditions before and after the change.

I have known several instances where increasing the speed has given excellent results without any disadvantages. It is apparent from card B that the cutoff has been shortened 15 per cent, and that the terminal pressure has been decreased from 20 to 14 lb. This alone is worthy of note as a coal saver. A. C. WALDRON.

Putting a Laundry Plant in Order

IN MOST laundry plants, the power end is the very last thing that the owners want to fix up or will fix up. Consequently they are most wasteful of fuel; the valve stems leak, unions leak, seats of valves are cut and scored, drips from coils and machines blow outdoors, boilers are dirty, and settings cracked, grates warped. Unless an engineer works 15 hr. a day, seven days a week, his plant will always be in that shape, and as most engineers like to have Sundays off, they just let things go. But I would rather have a good clean boiler and everything in good shape before I take a Sunday off.

Hiring out on one laundry job over the telephone, I never saw the plant until I went to work Monday morning. Upon my arrival, the fellow who had been running was just starting the fire. There was about an inch of water in the gage and he had a roaring paper and wood fire. The water was just getting warm and he was forcing the fire so hard that the old boiler almost jumped out of its setting.

"Hold on, fellow; I am going to run this plant if the boiler stays in place while I get up steam," were my words of self-introduction. So I shut the drafts and put on a good supply of coal and let it come up easy. When the pressure got up to 20 lb. of steam, I opened the blowoff valve, but it did not blow. Upon inquiry, I was told that he had not opened the blowoff valve since he had been there, and he had been there five months. It remained shut for a few hours.

He blew the tubes once or twice a week and they surely looked it. Did he scrape them? He had no scraper or brush. When steam got up to 60 lb., the hiss of leaking steam was deafening. The engine was a piece of junk. The connecting rod shook like a rattle, the brasses at both ends, crosshead and crank, were driven right up together. When started, it almost fell apart, and when they put on the load, my hair stood right on end.

The forenoon passed without accident, and while shut down at noon I took out the crank brasses and filed them down and took up the main bearings, and it ran a little quieter in the afternoon. That night I let out the fire and left the damper and doors open, got something to eat and came back and went to work on the engine. I scraped the crosshead brasses, filed them down, scraped the eccentric strap to a good bearing, packed the piston and valve rod, and as it was then 11:30 and the pressure was all off the boiler, I took off the bonnet of the blowoff valve and found a 2-in. blowoff pipe just plugged full of rust and scale that had to be chiseled out. Finally the water would run through and it was just like mud.

All the water was let out and the boiler filled again with hot water from a 1200-gal. tank. While it was filling, the tubes got a scraping, as I had sent out for a scraper in the afternoon. It was an awful job getting the scraper through those tubes; blistered hands and cuss words mixed freely in the air. It was 5 a.m. when this work was finished, so I started the fire, got some breakfast, soaked my head in a bucket of cold water and called it a night's sleep.

Wheels went around until Saturday, then I pumped 30 lb. of soda ash and a quart of kerosene into the boiler, as the load was very light, and let it cook. Sunday morning, I let out the water, opened up handholes and manhole and found the scale was almost half an inch thick, but the soda ash had softened it so that the most of it washed off with the hose. The safety plug proved to be a common pipe plug. After this cleaning up my work was just half as hard. I could keep plenty of steam and I could hear a pin drop as I had packed all of the valves.

At the end of the first month the boss came into the engine room and said, "What's the matter? I used to sit in the office and know when the engine was running, and now I have to get out where I can see the shafting move," and he said, "We have done more work this month and only used a little more than half as much coal." I had been there 3 months when he called me into the office and said here is a little present for you; it was a check for $100. He is the only one of many that really cared whether things are right in the boiler and engine room.

I use half a pound of soda ash to a boiler horsepower, and a quart of kerosene, and it keeps my boiler in fine shape. I put it in when I am running, and the kerosene keeps it from foaming if the load is not too heavy.

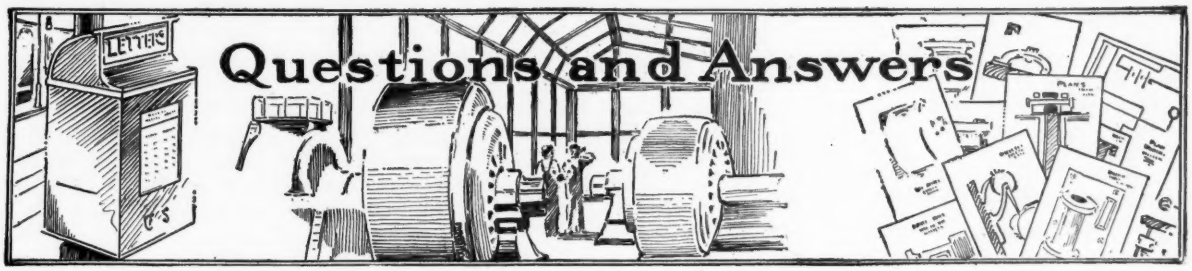
I would rather work in a state where there is a license law, as it takes off some of the responsibility, and you don't have to fight so hard to get your repairs and keep things in good shape. N. R. MORRELL.

Fastening Pipe to Walls

QUITE OFTEN the appearance of a run of conduit can be improved. Here is one solution in regard to running switch or outlet legs. Instead of using clips to fasten the pipe to the wall, drill one or two holes in the back of the fitting large enough for No. 8 wood screws. Make-up pipe and fitting, screw the fitting to the wall and you have a tight job. This saves the necessity of putting unsightly clips around the pipe and at the same time makes a good, permanent job.

DEAN B. COBB.

THE NONCOMPRESSIBILITY of water, coupled with the thickness of some men's heads, has helped the repair shops to several millions of dollars of work. We cannot change the nature of water, but we can do something with the men's heads.—MARINE ENGINEERING.

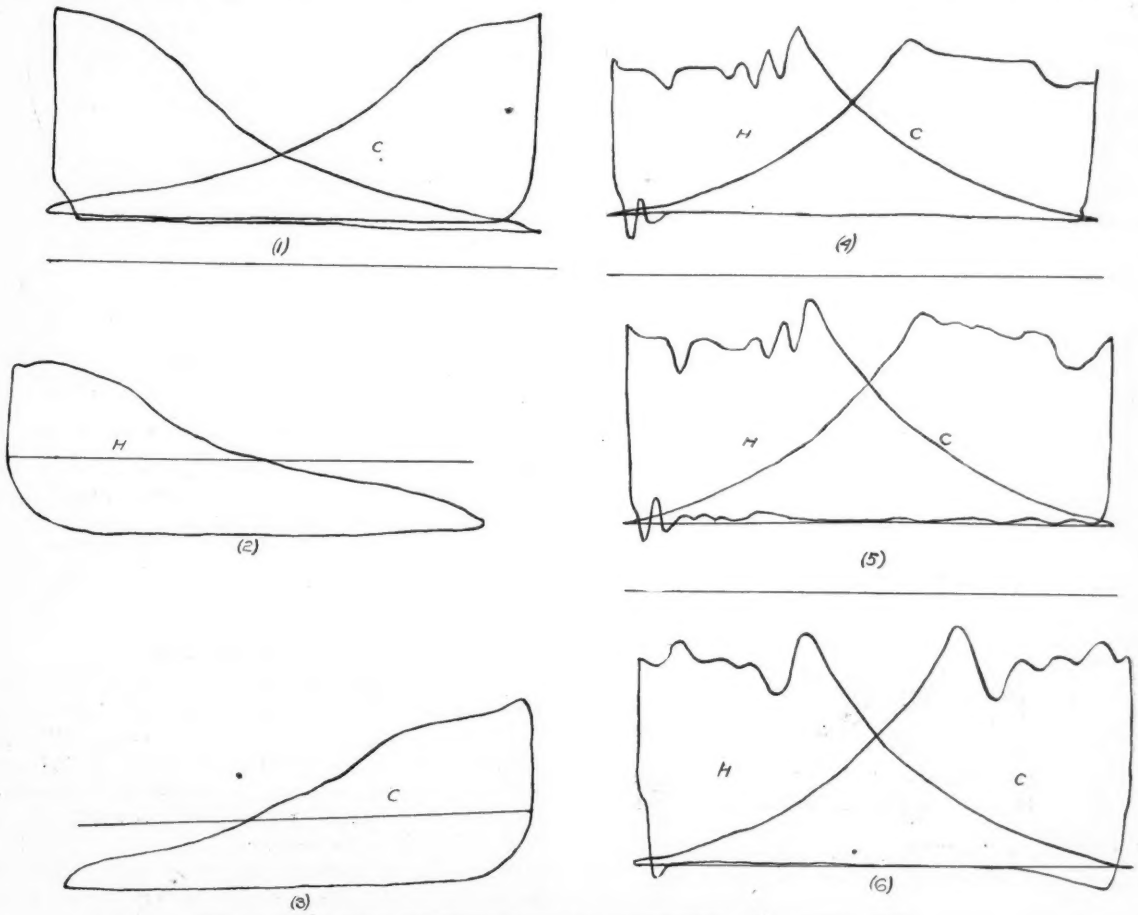


Air Compressor Cards for Criticism

REPRODUCED HEREWITH is a set of indicator cards taken from an Ingersoll-Rand air compressor. The steam end is compound and runs condensing, the dimensions being 18 and 28 by 20 in. The speed is 112 r.p.m., boiler pressure 130 lb., receiver pressure 12 lb., vacuum 24 in.

Cards No. 1 are from the high pressure cylinder taken with a 60-lb. spring. Nos. 2 and 3 are from the low-pressure cylinder, a 20-lb. spring being used. No. 6 is from the low-pressure cylinder taken with a 20-lb. spring.

I wish to have readers criticize these cards, pointing out the defects and how they may be remedied, and calculate the horsepower developed. H. B. M.



SET OF CARDS FROM INGERSOLL-RAND AIR COMPRESSOR—¾ ACTUAL SIZE

Two-stage air compression is employed, the cylinders being 15 and 25 by 20 in. In the first stage, air is brought from atmospheric up to 27 lb. pressure and in the second from 27 to 98 lb. Card No. 4 is from the high-pressure cylinder taken with a 60-lb. spring, and No. 5 from the same cylinder, using a 50-lb. spring.

Ports of Engine with Throttle Reverse

IN THE issue of Power Plant Engineering dated July 15, F. H. wants some of the readers to tell how the valves are ported and how the steam travels to reverse the engine with a throttle reverse.

With all such engines that I have seen and used, the valve was worked as an indirect valve for one direction of rotation and as a direct valve when reversed. The throttle reverse simply changes the steam port from

the center to the outside and from the outside back to the center of the engine valve.

In Fig. 1, the slide valve B acts as the reverse. As can be seen, the steam is flowing to the center of the piston valve, which is working indirect or admitting steam past the inside edges and the exhaust flows to the ends of the

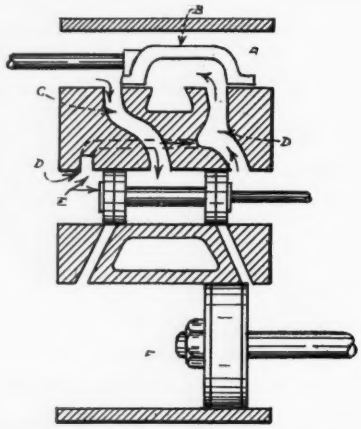


FIG. 1. SECTION THROUGH REVERSING ENGINE VALVES

piston valve, which is working indirect or admitting steam past the inside edges and the exhaust flows to the ends of the piston valve, then through the port D to the exhaust cavity of the slide valve and then to the atmosphere.

Now if the slide valve is moved over, D will get live steam and port C will be under the exhaust cavity of the slide valve. Then the piston valve will work as a direct

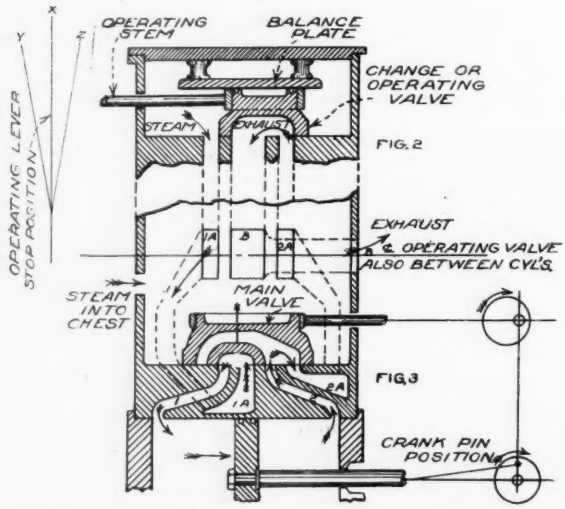


FIG. 2. SECTIONAL VIEW OF MAIN AND CHANGE VALVES
FIG. 3. SECTIONAL VIEW OF CHANGE VALVE

valve admitting steam past the outside edges and exhausting from the center, and the engine will run in the opposite direction. Live steam is admitted at A. One of the ports D is shown dotted. E is the piston valve and F is the main piston. PERRY BARTRAM.

IN RESPONSE to the request of F. H. in the July 15 issue, I wish to present my method of reversing a duplex steam engine equipped with an eccentric for each cylinder and having cranks placed 90 deg. apart.

Figure 2 shows one cylinder, main valve and change valve seat, ports and ducts of a double cylinder reversing engine. Figure 3 shows a sectional view of change valve with operating lever in Z position, which causes steam to enter port 1A, Fig. 2, and flow as shown by the arrows. With operating lever in Y position, Fig. 3, steam enters port 2A, which reverses the direction of rotation of the engine.

To set valves see that center line marked X in small cavity of main valve coincides with center line marked XX in port 1A, when crank is on either dead center.

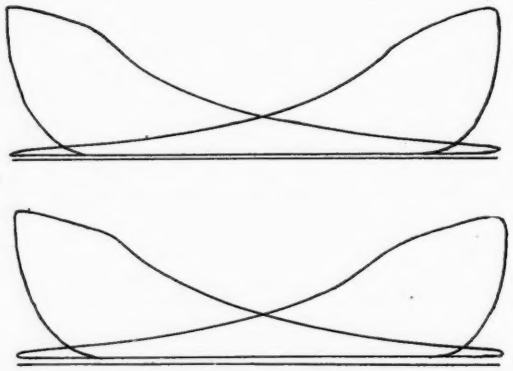
These valves have neither lap nor lead.

J. A. WEICHEL.

Card Criticism Desired

CRITICISM IS desired of the accompanying indicator cards taken from an Allis-Chalmers Corliss engine, 22 by 42 in., run at 120 r.p.m. The scale of spring used was 70 lb. and the boiler pressure was 90 lb.

The steam connection is 8 in. in diameter, with a



INDICATOR CARDS FROM ALLIS-CHALMERS ENGINE

small separator over the engine. Between the header and the engine are about 90 ft. of pipe, consisting of 12-in. header, 10-in. pipe about 40 ft. long and the remainder 8-in., all well drained. The exhaust connection is 9 in., which connects into a 10-in. pipe.

PAT.

Pulley Calculations

I HAVE A MOTOR operating at a speed of 1000 r.p.m. and equipped with a 6-in. pulley which I desire to use in connection with a machine having a 10-in. pulley and which is to be run at a speed of 150 r.p.m. I find, however, that it will be necessary to employ a counter shaft and wish you would inform me how I may calculate the speed and pulley sizes required. C. B.

A. In the problem of calculating pulley diameters and speeds, there is one rule which is very important and should be kept in mind at all times. This is, that the diameter of the driven pulley, in inches, times its speed, in revolutions per minute, is equal to the diameter of the driving pulley, in inches, times its speed in revolutions per minute.

In the problem you present, we have the diameters of the motor and the driven machine pulleys, also their

respective speeds, and the problem is to determine not only the speed but also the diameters of the pulleys on the counter shaft. We have, arbitrarily, selected a speed of 300 r.p.m. as that most suitable for the counter-shaft. Then applying the rule given above, we find that the product of the diameter of the motor pulley times its speed is equal to 6 times 1000, or 6000.

The speed of the counter-shaft is supposed to be 300 r.p.m., so that the diameter of the driven pulley on the counter-shaft must be equal to 6000 divided by 300, or 20 in. The speed of the driven machine is supposed to be 150 r.p.m. and the diameter of its pulley is 10 in. The product of these two factors is 10 times 150, or 1500. Again considering the speed of the counter-shaft, we have 300 r.p.m. Dividing the product of the driven machine speed by its pulley diameter, or 1500, by the speed of the counter-shaft, or 300, we have a driving pulley diameter of the counter-shaft of 5 in.

Distillation of Naphtha

I AM EMPLOYED in a large machine shop where they use about 175 gal. of naphtha every week to wash the oil off the finished work. I think that there is some way of reclaiming some of this naphtha after it is used instead of throwing it away. I would greatly appreciate any helpful suggestion that you may give.

I have tried filtering it through excelsior, sand and coke; but that is not just the thing, as it is discolored, but not so badly as before filtering. If there is anything on the market in the line of a distiller that will do the work I am interested and would like to have the name of it, and if not I could make one up myself if I knew just what an oil distiller should be and whether the vapor pipe should be piped into a closed vessel to condense the vapors. The steam pressure available in the summer months in my plant is 10 bbl. If you know of anything that will be helpful to me in this line, kindly inform me.

J. J. L.

A. We see no reason why you cannot distill your naphtha and thus reclaim it for reuse. Of course, this must be done by a steam still. It would not be safe to handle the naphtha in any place where there is any flame, nor do we know of any commercial still made for such purpose.

The general features of such a still would be a chamber having a rather shallow pan at the bottom, into which the naphtha could be placed, and, with steam coils running through the naphtha, to heat it to the vaporing point. This naphtha vapor would, of course, pass off from the top of the chamber and be carried to a worm or a tube condenser, where it would be condensed by the flowing of cold water, and then discharged into a vessel kept at a comparatively low temperature, which should be vented from the top.

Our thought in the matter would be that a small pipe condenser—made up much like an ammonia condenser—would best serve for this purpose, drawing the condensed naphtha from the bottom of the condenser, by gravity, into a receiving tank. This process should remove all of the impurities from the naphtha, but may not remove the discoloration. We do not, however, see that that would have any ill effect for the purpose for which you are using the naphtha.

You would have to regulate the temperature of distillation so that you would evaporate the naphtha and not carry over the lubricating oil constituents. This could be done by regulating the steam flow to the heating coil, or regulating the pressure in the coil. Just the temperature that you would need would depend on the quality of naphtha you are using, and also the gravity of the lubricating oil which you want to separate from the naphtha.

The process would probably not be a continuous one; that is, you could not send naphtha in continuously, and draw the residue out continuously. You would have to charge the still, run it until, by experience, you found that the naphtha had all been driven off, and then take out the residue and recharge the still.

Coal Saving by Returning Condensate

WE HAVE a copper kettle, used for cooking, containing a copper coil 1½ in. in diameter, using steam at boiler pressure, 90 lb.; the condensation discharging through a steam trap into an open tank. The total amount of water discharged through the trap at each cooking (from 6 to 7 hr.) is 6300 lb. Now, what we wish to know is this: How much coal could we save by installing a direct return steam trap and discharging this water directly back into the boiler? The temperature of feed water discharging into the boiler from closed heater at present is between 190 and 200 deg. F. The 1½-in. valve controlling the steam to this coil is kept wide open during the entire cooking process, thus keeping the steam pressure in the coil at practically boiler pressure, 90 lb. A. J. S.

In regard to the coal which you can save by returning the condensation from your cooking kettle to the boiler, the condensation at 90 lb. pressure will have a temperature of 331 deg. Figuring your present feed water temperature at 195 deg., this would give a difference of 136 deg. For 6300 lb. of water, this would mean 856,800 B.t.u.

Assuming that your coal has a heat value of 13,500 B.t.u. per pound, and that the boiler and furnace efficiency are 60 per cent, each pound of coal would deliver about 8100 B.t.u. to the boiler.

This would mean that you would save about 105 lb. of coal by returning the condensation to the boiler instead of throwing it away.

How May This Trap Be Fixed?

WE HAVE nine traps of well-known make in our plant, one of which, however, has caused me considerable trouble by remaining continually open; the bucket will not float.

I have taken the matter up with the manufacturer's representatives, who upon suggestions received from their main offices put forth the argument that the bucket must be waterlogged.

Who ever heard of cast iron becoming waterlogged?

I want to grind the bucket so as to make it lighter, but the manufacturers advise placing it in a hot fire in order to dry it out thoroughly.

Not knowing what to do, will some one of Power Plant Engineering's readers kindly tell me how I may fix this trap? OPERATING ENGINEER.

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Compiling Plant Data for War Service

Every engineer having supervision over the preparation and use of power plant data will do well at this time to make a point of assembling such material for immediate reference in case he is called upon by the government authorities for information relative to his coal consumption, loads, equipment and other service matters. Of course, a large amount of important work along these lines has been performed by government engineers with the aid of the operating men since we entered the war; but plant conditions are changeable, and up-to-the-minute information should be "on tap" at all times for Uncle Sam's use and convenience.

Many engineers rely too much upon their memories in giving out statistical information regarding their stations; but whether recollections are to be trusted or not, it is a good plan to keep at least a loose-leaf book of plant data ready for instant and accurate use at the telephone or wherever else the information may be needed. It is no excuse for failing to keep a record of this kind to contend that it is of little value because the chances are against its being wanted in a hurry. We are at war, and there is no such thing as being too well prepared for eventualities, on the industrial side as well as on the fighting fronts.

Thus it is easily conceivable that the time may come when some particular power plant may be called upon to lend a pump of a stated size to somebody else, in order to fill in a gap caused by a breakdown on some branch of station service intimately concerned with the completion of a rush order for war supplies for immediate overseas shipment. There should not be ten seconds' delay in answering an inquiry from the proper authorities as to whether a pump of the type and size required is in service at a particular station; whether it can be spared without shutting down the production of power from any other class of war material; how much the equipment weighs, if known, and where it was originally obtained, with the cost. The operating engineer may urge that the Government should have amassed all this information in its original power plant survey work in the locality in question; but whether that is so or not, it is necessary to look to the plant engineer for a responsible statement of present conditions. Power surveys are helpful indeed in relation to the war, but we cannot afford to base our actions solely upon the data of a survey perhaps weeks or months old if the latest word on plant conditions can be had, and at a moment's notice, too.

It is altogether too easy in this world to settle back and take refuge in past accomplishments, assuming that previous conditions have been maintained ever since the last investigation was concluded. A steam plant generates electrical energy in a particular month, for instance, at 1.9 lb. of coal per kilowatt-hour. Fine work! And immediately the 1.9-tag is fastened to this station and its reputation goes abroad, so that for months and perhaps years to come, even, the outside world *assumes* that 1.9 lb. is the regular performance and counts upon it in all power economic studies. One of these pleasing monthly summaries gets into the hands of the state fuel administration, let us say, and from then on estimates of the amount of coal which will be needed from month to month by a given community are based in part upon

this high efficiency station record. Actually it may very easily happen that through changes in the quality of the coal, labor uncertainties, load shifts beyond the control of the plant staff to handle at maximum economy, a failure in the condensing equipment piping, or some other unexpected cause, the following month's output may be at 2.2, perhaps even 2.5, lb.

It is hardly necessary to say that the maintenance of concise summaries of plant equipment and performance will do away with the necessity for guesswork as to general tendencies, and the availability of any particular station or of its parts for immediate service, locally or otherwise, is correspondingly increased. Not the least advantage of such information for instant use is that it establishes a first line of defenses against amateurish attacks on the plant itself in many cases by well-meaning but non-technical gentlemen who go up and down the land with the ready-made conclusion in their heads that every isolated plant should at once capitulate to the central station as a war measure—a surrender that every honest engineer would expect to make if such a conclusion were economically justified, but which should be opposed with real data of continuous value in all cases where the balance of power, so to speak, lies on the other side of the wall.

The Control of Employes for War Work

A Subject That Affects All Who Are in Any Way Susceptible to Use for the Prosecution of the War and Its Aims. By A. P. Connor, Washington Correspondent

WILL YOU be drafted by the Government for the furtherance of the war in one of its industrial forms? This question will appeal to everybody that keeps in touch with what is going on, particularly when the following paragraph from the official announcement of the Department of Labor is considered. This paragraph says:

"While the restrictions against the private employment of labor apply only to common labor at the present time, these restrictions will, as soon as possible, be extended to include skilled labor. In the meantime, recruiting of skilled labor for war production will be subject to federal regulations now being prepared."

What does this mean? It is broad enough to mean everything; in other words, it could include conscription. The Department of Labor, however, have in answer to an inquiry of the writer denied that any such radical step as conscription of labor is intended, or that the Constitution would permit it. The point, however, that will appeal to the readers is that the qualification of "skilled labor" can include every reader, even if he does no mechanical work. In other words, the engineer who is skilled intellectually is just as apt to be included as the skilled artisan in the future "orders" of the Government, should it become desirable.

The question of labor is complex, and can lead to unending argument and discontent; unfortunately, the matter appears to be given less consideration by the Government than by the industrial field on the outside, especially with respect to unorganized technical help. The results of the efforts of the Department of Labor with respect to the settlement of labor troubles on the outside have been highly commendable. The industrial managers of the country appear to have been liberal with employes during these times of stress, and if anything have been encouraging labor to an unprecedented state of prosperity. The wages of labor have in many cases reached to 500 per cent more than normal. The technical and engineering professions, however, have not fared so well, but this phase seems to be adjusting itself.

Theoretically, the Government is not going to draft labor; but practically it is considering and arranging to take over a most comprehensive control of the supply and use of labor, both skilled and unskilled. The real purpose of the Department of Labor is, in fact, that of a clearing house, having for its object a stabilizing of labor during the war period. It is taking charge of the recruiting of labor in a supervising way, and has in mind the adjustment in the most satisfactory way of the difficulties involved. These are great and require the greatest tact, but it is believed that they will be handled satisfactorily as far as the legitimate rights of labor are concerned.

In the official explanation of the program, the basic principles are given, reasons stated and the method of procedure outlined. Extracts, as given in the official Bulletin, follow:

Adoption of the National Labor Recruiting Program has been made necessary by the decreased supply of labor, due to cessation of immigration, "labor poaching" by one war industry on another, movements of working back and forth over great distances, recruiting of labor by private and public agencies without reference to local needs and resulting hoarding of labor supply by some communities to meet anticipated needs. Some industries have had an over-supply of workmen; others have been disastrously short of laborers.

To relieve the situation, the War Labor Policies Board is composed of authorized representatives from the War, Navy, Labor and Agricultural Departments, War Industries Board Shipping Board and Emergency Fleet Corporation, and the Food, Fuel and Railroad Administrations. The program will be enforced, first, by the desire of every patriotic citizen to comply with the policies of the Government; and, second, by the full power of every governmental department represented.

This program is based on the principle that, in time of war, all the labor resources of the country should be a common supply for all industries connected with the war. And that all industries not directly connected with conduct of the war should contribute their share of the labor needed by the war industries, so that the latter may at all times be fully manned.

By a central agency, the contributions of labor from non-war industries can be equally distributed, and available supplies of labor appointed to war industries according to their needs. To do this the agency must have accurate information as to the demands for labor in war industries, the power to withdraw workers from non-essential production, the ability to control unwarranted competitive bidding in wage increases, the good sense not to take men away from war work, railroads or farms, and

to move workers when necessary from points as near as possible to the demand.

Recruiting and distribution will be controlled by paid officers of the U. S. Employment Service and by agents of the Public Service Reserve through central and branch offices. Stabilization of wages in war work will be in the hands of the War Labor Policies Board, and will be enforced by the governmental departments, which will also use their power to control private recruiting of labor and competitive bidding.

This program went into effect Aug. 1 in regard to unskilled labor, that being dealt with first because the shortage was most acute. It is expected that it will be applied shortly to certain kinds of skilled labor in which the total supply is less than the demand, and to other branches as the need becomes evident.

When it becomes evident that war industries are not supplied with men in any given branch of skilled work, the country will be combed to locate all men on such work in non-war industries, and the supply will be distributed according to the needs. If the demand is greater than the total supply, the matter of priority will be determined by the Board and local questions by local labor boards.

Workmen are, of course, at liberty to secure employment direct from employers, but it is urged that they secure it through the Employment Service, so that their labor may be available where most needed to help win the war. A man will be given as definite advance information as possible as to terms and conditions of a job, and is not obligated to accept the job when he gets to it, although he ought not to refuse to go to work after being transported under government auspices except for good reason and should then refund any transportation paid.

There is no limitation as to the time a man must work on a job to which he has been sent by the Service, but as such work will be essential war service, he is urged not to desert his post except for the best of reasons. The man himself will be the judge, however.

Wages will not be paid for time needed to go to a job, but transportation will be paid, or advanced and deducted from wages later. Food will usually be arranged as part of the transportation, but definite information will be given in each case before a man starts for a job.

In general, men will be recruited for particular jobs of which all terms and conditions are known. Local supplies will be used as far as possible to meet local demands, and where movement is necessary it will be so conducted as to require the least possible traveling. Movement within a state will be in charge of a State Director, and from one state to another will be controlled from Washington and arranged for between the State Directors concerned. Men will be moved in parties under an officer of the Employment Service, being first examined as to qualifications and physical fitness. Transportation will be paid by the Service and collected from employers benefited.

It is urged that employers needing men or men wishing to get into war work should apply to the nearest branch of the Employment Service, stating needs or qualifications, and await the advice of the officers of the branch. Meantime, workmen should continue at their present employment until advised to change.

At present, employers engaged in non-war work and those engaged in war work who employ less than 100 males, exclusive of clerical and administrative force, are required to refrain from endeavoring to get unskilled labor from the Government or from employers engaged in war work. They should advertise for or recruit labor only under supervision of the local representative of the Employment Service. Employers in war work, whose force is 100 men or over are prohibited from recruiting unskilled labor through private agents or agencies, except their own field forces, and then only under control of the Employment Service. They may hire unskilled laborers who come without solicitation other than signs posted at the place of employment.

As to skilled labor, no solicitation by advertising offering superior inducements is permitted of men employed in war work, and advertising must be done under authorization of the local representative of the Employment Service. No advance payment or interstate transportation may be offered, except by consent of the Employment Service. A skilled man who is unemployed and applies for work may, however, be hired.

In general, it is not intended to interfere with freedom of contract between the man seeking work and the employer, but to restrain employers from campaigns for labor which will tend to create unrest and shipping of workmen and to prevent robbing one locality of workmen to supply another.

Labor for farms and railroads, for non-war work and for small establishments is not at present restricted, but solicitation must not be such as to draw away men already employed in war work or to result in competitive bidding with employers engaged in war work and with large establishments.

Employment for Engineers

FOR registering engineers who are available for positions, and furnishing engineers to employers who need them, the United States Employment Service has established a Division of Engineering.

The privileges of this division are open free of charge to all engineers and technical men, either for war work or other work.

Last month 468 applications for help were received, 1314 applications for positions, 1063 applications were referred out and 483 men actually located.

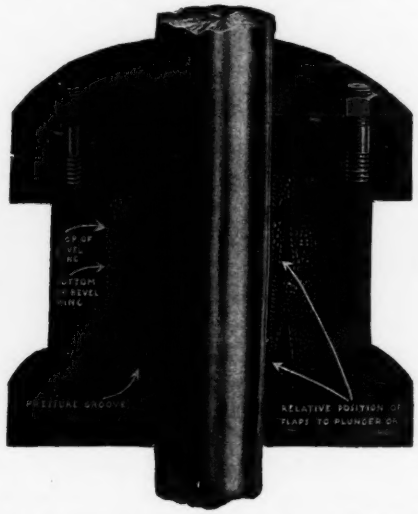
The Division of Engineering has its central department in Chicago, where records of experience and applications for men may be sent, and it is proposed to establish local branches in every large industrial center.

ANNOUNCEMENT is made by Secretary McAdoo that the interest rate on the Fourth Liberty Loan will be 4¼ per cent. He points out that a raise in rate of even one-fourth of one per cent on ten billion dollars of bonds would mean an annual increase of $25,000,000 in interest charges, which would have to be raised by increased taxation. He says that we should, therefore, take a stand to stabilize the interest rate for financing the war at 4¼ per cent, and protect ourselves against successively increased rates on government loans.

Ring Packing with a Flap

THIS packing for piston and valve rod stuffing boxes is made, as shown by the illustration, with a bevel ring, inside which rests a flap ring of soft, pliable material, forming a groove into which water, steam or air may enter, thus causing the flap to hug the rod under all conditions, but only enough to prevent leakage under the pressure then existing around the rod.

When pressure is removed, the flap springs away from the rod or plunger, removing all friction. The makers, Triangle Packing and Rubber Co., state that this Triangle Flap Ring Packing is especially effective



SECTION OF STUFFING BOX PACKED WITH TRIANGLE FLAP RING PACKING

when a rod is scored or out of line, and that glands need be screwed up only finger tight to do the work.

A Rust Preventive

THE Dearborn Chemical Co. has just made general announcement of the inauguration of a specialties department, for the manufacture and marketing of a number of specialties of interest to manufacturers of steel products. Perhaps the most important of these is a rust preventive, known as No-Ox-Id.

Metallurgists and dealers in iron and steel products have long sought a satisfactory article for this purpose, and it would seem that the Dearborn Laboratories have solved the problem.

No-Ox-Id is already in use in many plants making tools and machinery, where it is essential or desirable to keep the metal parts or the finely finished surfaces of the completed machines free from corroding, disfiguring rust. Munition manufacturers and certain government departments have adopted it.

Other specialties developed by the Dearborn Laboratories are Cutting Oils for use in metal cutting, to lubricate the cutting tool and prevent overheating; Quenching Oils, for heat treating; Drawing Oils, and Dearboline—a preparation for cleansing machined parts of emery or grease.

Each of the products manufactured and marketed by this new department of specialties has not only been proven in an experimental way in the Dearborn Laboratories, but the reasons for failure of other materials designed for the same purposes were determined, and products built to overcome such conditions and provide all the necessary qualities to produce perfect results.

These products have all been submitted to reliable concerns for rigid practical tests, covering periods of 2 yr. or more, in order to prove their value.

News Notes

THE SEMI-ANNUAL MEETING of the American Gear Manufacturers' Association will be held at the Onondaga Hotel, Syracuse, N. Y., Sept. 19, 20 and 21.

Announcement of the program will be given in a later issue.

GEORGE W. HEALD, who has been Engineer of Pumping Station Efficiency in the City Engineer's office, Chicago, has recently been put in full charge of the Operating Division, which includes all water and sewage pumping stations and cribs throughout the city.

THE CHICAGO PNEUMATIC TOOL CO. announces the appointment of C. W. Cross as Special Representative for the sale of pneumatic tools to railroads, vice L. C. Sprague, promoted to be District Manager of Sales for the company at New York.

W. A. FULLER and A. H. Beard recently organized the firm of Fuller & Beard, Engineers, Chemical Building, St. Louis, Mo.

W. A. Fuller, formerly of the Fuller-Coult Co., had charge of the designing of the water supply, fire protection, sewer system and sewage disposal, as sanitary engineer for the United States Shipping Board, Emergency Fleet Corporation, at Hog Island, Pa., and having completed the work for the Government, has returned to St. Louis.

A. H. Beard was with the American Water Works and Guarantee Co. of Pittsburgh, Pa., from 1905 to 1908, as construction engineer on the constructing of their water filtration plants at South Pittsburgh, Pa., Suffolk, Va., Chattanooga, Tenn., and St. Joseph, Mo., and for the past 10 yr. has been Superintendent of Construction for the Pennsylvania Department of Health in charge of all construction at the State Sanitoria at Mont Alto, Cresson and Hamburg, Pa., including water works and sewage disposal.

E. P. DILLON, manager of power division, New York office of the Westinghouse Electric & Mfg. Co., has resigned to become general manager of the Research Corporation of New York. Mr. Dillon came to the Westinghouse Co. in 1909, having been previously connected with various mining and electrical companies in Colorado. In 1917 he was transferred to the New York office as manager of the railway and power divisions. For several years he was assistant to manager of the railway and lighting department at East Pittsburgh, being in charge of power house and apparatus work. He was transferred to the New York office as manager of the railway and power divisions in 1917. Mr. Dillon has a host of friends who wish him success in his new position.

CAPTAIN EDWARD H. PHILLIPS, E Co., 104th Infantry, an employe of The L. S. Starrett Co., of Athol, Mass., was killed in action in France on July 25. Captain Phillips was an example of the finest type of young American manhood. He was a sergeant when the company was formed and was rapidly promoted to second lieutenant, first lieutenant and captain. Last spring he received the Croix de Guerre from the French Government.

The L. S. Starrett Co. has 124 employes in the military or naval service of the United States and Great Britain.

IN ORDER to help out the situation in the Pittsburgh district, where the present power supply is inadequate for the government and other work placed there, the West Penn Power Co. has agreed to build a 40,000-kw. station at the mouth of the coal mine in the Allegheny Valley and to connect it up, by appropriate transmission system, with the distribution system of the city of Pittsburgh.

The estimated cost of the plant transmission lines is $5,000,000. The Ordnance Department will advance $2,000,000 of this amount, and the company, through its bankers, will provide the other $3,000,000.

At a period 3 yr. after the end of the war the reduplication cost of the plant is to be determined by three disinterested appraisers, and their finding is to be subject to review and revision by the Secretary of War. The company undertakes to replay to the government such part of the advance made by the government as represents the excess of the appraised value over the $3,000,000 originally put up by the company.

Propositions received from other companies to extend their power plants or build new ones in the Pittsburgh district if the War Department would advance 40 per cent of the cost and the finance corporation 60 per cent are not looked upon with favor by the government. Lacking more favorable propositions, the government has under consideration the building of its own plants where they are needed in this district.

Catalog Notes

THE MAGNESIA ASSOCIATION of America has recently issued specifications for 85 per cent magnesia, non-heat-conducting coverings for power and heating systems. These specifications are complete, and would be an aid to all engineers contemplating the installation of various steam and exhaust pipes, heaters, etc. The booklet also contains price list, curves showing proper thickness of insulation to be installed, and tables showing the thickness of magnesia for maximum net saving.

CATALOG NO. 10 has just been issued by the Defender Automatic Regulator Co. and contains descriptions of the combustion appliances, efficiency instruments and regulators for the boiler room manufactured by this company. Among these appliances are pressure gages, draft gages and pyrometers of different types mounted upon boards in various arrangements most suitable to individual plant conditions; vacuum gages, flue gas analysis instruments, thermometers, recording instruments, damper regulators, etc. Numerous types are illustrated, each designed for some special condition, thus giving the purchaser a wide variety from which to select.

G-E DIVISION, Edison Electric Appliance Co., 5660 W. Taylor St., Chicago, is sending out a circular relating to the G-E electric flat iron and illustrating a model window display.

POWER TRANSMITTING MACHINERY made by Lewis E. Tracy Co., of Boston, Mass., is illustrated in Leaflet F, which also gives price lists of the various transmission accessories.

MANUFACTURING Equipment and Engineering Co., 136 Federal St., Boston, has lately issued circulars illustrating its metal sanitary and fireproof equipment for factories, foundries, public buildings, etc.

STEEL CITY ELECTRIC CO., of Pittsburgh, Pa., has just issued its new catalog, No. 33, a complete catalog which cancels and supersedes previous separate bulletins, and which the company will gladly send to any concerns not supplied with a copy.

PORTABLE BORING BARS for reboring cylinders, Corliss valve seats, etc., are illustrated and described in Bulletin K of E. J. Rooksby & Co., 435 N. Eleventh St., Philadelphia.

AIRSPRING compressed air grease cups, made by Hunter Pressed Steel Co., Lansdale, Pa., are described in a new circular from that company.

Trade Notes

THE CANADY-BLAISDELL CORP., 90 West St., New York, has brought out a new undergrate draft system, which it is claimed is meeting with marked success. The principal feature of this system is the Canady Undergrate Draft Controller, designed for the automatic regulation of the air supply to fuel beds of varying density. The manufacturers state that this device has been tested in actual service, in various installations, over a period of 18 mo. with highly satisfactory results.

THE OHIO BRASS CO. announces that present unusual conditions make it practically impossible to estimate the probable future cost of manufacturing brass valves; the needs of the government, developing from day to day, preventing the determination of future shipping dates with any degree of certainty. It has been deemed necessary to adopt the following: All orders will only be accepted subject to shipment as promptly as conditions will permit and to being invoiced at the company's prices in effect at time of shipment, subject to the following exceptions:

First. Orders received direct from the United States government.

Second. Orders received from jobbers for shipment direct to a government operation.

Such orders will be accepted to be invoiced at the prices in effect at the time the order is placed.

FLAKE GRAPHITE as prepared by the Jos. Dixon Crucible Co. is concentrated from undecomposed oil so that the natural smooth dense surface is unimpaired. The flakes are thin, giving large lubricating surface in a given weight. Any foreign matter contained in the Dixon Flake Graphite is held between the laminae of the flakes, where it can do no harm.